Summaries of Discussion Groups and Closeout

Discussion Groups

BIW registrants were asked to select their top six choices for group discussions from the following topics:

Commercial rf Technology and Beam Instrumentation
4th Generation Light Source Instrumentation
Feedback Systems
Challenges in Beam Profiling
Beam Loss Monitors
Calibration Methods
High Resolution and Highly Stable BPM Methods
Closed Orbit Monitoring
Polarimeters and Applications
Low Current Monitors
Linear Collider Instrumentation
Colliding Beam Instrumentation

The first seven topics were the most popular and discussion groups were held accordingly. Summaries of these discussion sessions and the closeout session, as submitted by the chairs, are given below.

Commercial Applications of rf Technology

Ralph Pasquinelli, FNAL

In general, discussion sessions that do not have a "seed" problem to solve are very difficult to conduct. This session was certainly one of those. I started out with a few anecdotal stories about how we have been building a 16×16 channel multiplexer for connecting various diagnostic signals to a myriad of spectrum and network analyzers, counters, and power meters. Our requirement was for 1 kHz to 200 MHz bandwidth with 40 dB minimum isolation. After a year of prototyping we came up with a unit that utilized 8 layer circuit cards and lots of components. That same year, Analog Devices came out with a chip that did exactly this function, only better than our discrete unit. We bought the chip and are using it now.

Most of the rest of the discussion centered on requests for peoples' experience with industry providing solutions to our accelerator needs. There was some discussion that industry would indeed get involved when the number of channels required was high enough to justify NRE costs and still make a profit. Industry is not willing to create components for sale, but only complete systems or stand-alone equipment.

Many of the instrumentation needs are such that the number of channels is low and very customized to the particular machine. For instance, even at laboratories where there are multiple accelerators, the diagnostics for the accelerators are typically customized for each, not allowing for the economy of producing in quantity.

Beam-Loss Monitors

Alan Fisher, SLAC

I began the discussion by reviewing the different applications for beam-loss monitors (BLMs). There are at least four tasks that a BLM may be required to do; some machines may need only one, while others need all four. The type of BLM of course depends on the requirements.

1. Detection of steady, low-level losses in a ring. For tuning, loss histories and correlation studies may be required. A counter works well in this case.
2. Detection of sudden, high losses in a ring for rapid tuning (or aborts; see item 4 below). Depending on the time scale involved, a counter may not count fast enough (due to pulse pile-up), may not get adequate statistics in the short interval involved, or may not be read often enough. An integration of the analog loss signal may be preferable.
3. Detection of one-pass losses, for measurement of injection loss in a ring or for a linac. A counter is certainly not adequate for this job: it would count either 0 or 1. Some sort of integration is again needed.
4. Machine protection, by aborting a stored beam or stopping a linac when losses are excessive. This requirement could accompany the other three cases. It is also helpful to record the loss distribution at the time of the event to diagnose the source.

PEP-II (SLAC). I then described the Cherenkov BLMs built for PEP-II (1). Each consists of a small, fast photomultiplier and a fused-silica Cherenkov radiator, all surrounded by 1 cm of lead and enclosed in a steel can for magnetic shielding (although this PMT can work in a 100 G field). The Cherenkov threshold (about 1 MeV) prevents response to synchrotron radiation, and the lead provides additional filtering. Despite the lead and steel, the detector weighs less than 2 kg and can be moved around the ring.

The PEP BLMs perform all four tasks above, using a processor that sends the signal through two input circuits, which together provide a wide dynamic range. The PMT pulses are counted and also RC-integrated over one ring turn. A peak detector then finds the worst turn in each 8 ms interval, and the result is digitized.

If the integrated signal exceeds a programmable threshold, we can choose to abort one or both rings. We need less than 30 μs to detect the loss and abort the beam, to avoid having the large stored energy in the beam burn through the vacuum chamber. (The beam spirals inward rapidly after an rf trip, and the BLMs provide a second level of protection for such an event.) The BLM processor then records the triggering channel and, through a daisy chain linking all the processors, causes all BLMs to freeze their most recent readings. We have not made use of the abort feature yet, but we expect to use it in the next run, as we scrape the beam tail against some new collimators.

Another daisy-chain signal provides a 100 μs gate during injection, when the BLM network is inhibited from aborting the stored beam, since faulty injection is a more likely source of a large loss (and stored-beam losses will persist after the gate). To measure the loss on the worst turn around the injection time, the peak detector is digitized and read within 3 ms after the inhibit interval.

HERA (DESY). Next, Karl Hubert Mess spoke of the BLMs they built for HERA's proton ring. A commercial version of these devices is now available from Bergoz, under license from DESY. Their original function was to prevent a quench of the superconducting magnets in the proton ring by aborting the beam when loss increases, and they have been very successful in that role. Since that time, they have also been used on the electron ring, to locate the source of sudden decreases in lifetime. This problem has been traced to dust from the distributed ion pumps getting into the beam.

Quench protection requires an 8 ms response time, and since the bunch spacing is 96 ns, a counter can offer good statistics. To generate the loss signal, DESY chose a PIN diode, which emits a pulse when a particle from the beam loss shower passes through. To avoid responding to the synchrotron radiation from the electron ring in the HERA tunnel, two diodes are placed back-to-back. A coincidence circuit ensures that only harder particles (from beam loss) can pass through both diodes and cause an output pulse.

Loss histories are recorded and can be studied after an event to look for correlations with other machine parameters, such as lifetime. To strike a balance between machine protection and false aborts, four detectors must exceed their thresholds for an abort.

APS (Argonne National Laboratory). The Advanced Photon Source uses a long coaxial cable to detect losses. By filling air-dielectric RF cable with a suitable gas mixture, the cable becomes an ionization chamber. The pulse traveling with the beam integrates the total loss, while the pulses heading upstream arrive spread out in time, allowing a determination of the loss site. This device, known at SLAC as a PLIC (Panofsky's Long Ionization Chamber), thus has two advantages: it can be run along the machine, to get good coverage, and provides good localization (in a one-pass device like a linac or transport line). SLAC uses PLICs running along the 3 km linac, along the various transport lines, and through each PEP injection tunnel and around the first arc.

However, a single PLIC cannot localize losses from stored beam. At the Advanced Photon Source, several PLICs run around the ring in segments, to provide some position information. Robert Merl presented some transparencies on behalf of Glenn Decker to show one of their PLIC's responding to a scraper in the booster-to-storage-ring transport line. However, the PLICs have been less successful in the APS ring, due to background from synchrotron radiation (It's hard to shield a PLIC with lead!). APS is now testing a PEP Cherenkov monitor to look for injection losses at insertion devices.

ALS (Lawrence Berkeley National Laboratory). Jim Hinkson has been using the Bergoz version of the HERA BLM at the Advanced Light Source. He showed plots of typical loss signals near scrapers and insertion devices for different lifetimes. Recently, when it was difficult to store a beam at ALS, Jim used the BLMs to quickly determine that the scraper had not retracted out of the beam. A problem that might have taken a day was resolved in half an hour.

We also discussed the behavior of the Bergoz BLM when saturated. When Jim injected beam into a fully inserted scraper, the first turn produced an unusually high and wide BLM pulse. The BLM showed nothing for the second turn, 660 ns later, and recovered to show a signal on the third turn. Signals were observed on the fourth, fifth and sixth turns. I then noted that in my own tests of this device, I observed a similar saturation for about 1 μs after a heavy blast.

References

[1] Fisher, A.S., “Instrumentation and Diagnostics for PEP-II,” in these proceedings.

Calibration Methods

Robert Webber, FNAL

The discussion session opened with about a dozen people in attendance. We found ourselves in a room with tables and chairs set up as in a lecture hall with everyone facing the front. The discussion chairman immediately involved participants by re-arranging the room set-up to form a “round table” type arrangement with participants facing each other. This activity was a good ice-breaker to facilitate discussion.

Discussion began with a suggestion by the chairman that DC beam current monitors (DCCT or PCTs) are ideal devices to calibrate because simple instruments are able to yield a very accurate calibration of the monitor. The discussion then turned to questions of the frequency response of such devices and how to assure calibration at frequencies other than DC.

Two potential problems with DC transformers were presented. This device operates by modulating the magnet bias of toroidal transformers at some frequency, typically a few hundred to a few thousand Hertz. It effectively operates as a chopper amplifier to translate the DC signal to be measured up to a frequency twice the modulating frequency. That second harmonic amplitude is then detected and interpreted as the DC component of the beam current. The resulting frequency response is like that of a sampled data system with the accompanying ability to alias “out of band” signals into an “in band” frequency. If the transformer is excited with beam or test current signals at frequencies that are harmonics of the modulating frequency, an output can be created which is indistinguishable from that caused by a DC beam excitation. This problem is generally avoided by packaging an AC transformer with the DC monitor to provide the desired high frequency response while nulling any currents in the DC section that could be aliased. A problem noted during construction and testing of a DC monitor at Fermilab revealed amplifiers in a high-gain feedback section of the electronics that saturated in response to signals at certain frequencies. This non-linearity also resulted in an output indistinguishable from that of a true DC beam current. Frequency response adjustments in the electronics were required to assure that saturation was avoided. A straightforward method was described to test for such problems. In the lab, a test current is injected into the DC monitor using a simple wire or, for very high frequencies, an impedance matched coaxial center conductor. A blocking capacitor of suitable value is included in series with the test current conductor to assure that no DC current is applied to the monitor. Test currents over a wide frequency range are injected into the monitor using an amplifier of suitable bandwidth and power capability. The monitor output is low-pass filtered and if any DC signal component is observed at the monitor's output in this condition, a problem with saturation or aliasing effects is most likely present. Signals within the monitor electronics can then be investigated to discover the source of the problems.

George Coutrakon of Loma Linda mentioned discussion at Loma Linda about a current monitor for accurately measuring the slow spill beam extracted from that machine. The difficulty is that the current is in the low nanoampere range. There was little discussion and no good idea for a solution to this problem.

Coutrakon then brought up the question of BPM calibration, describing the observation of beam motion in the Loma Linda transport lines that seems to correlate with the beam intensity in the ring. It was noted that the Loma Linda machine uses a BPM signal for feedback in the low-level rf system to control beam energy and position. It was hypothesized that, if this BPM signal were intensity sensitive, the orbit in the machine and therefore the extracted beam position would be intensity-dependent. It was suggested that any intensity sensitivity of the BPM electronics could be determined under controlled conditions on a test bench. Another suggestion was made to use the actual beam signals in a controlled manner as test inputs. The signal from one pick-up electrode, or the combined signals from several electrodes, could be amplitude-controlled by an attenuator and then equally split into the electronics inputs to simulate an "on center" beam. A suitable amplifier might be included upstream of the signal splitter, if necessary, and attenuators downstream of the splitter could be added to simulate off-axis beam positions. This method assures that testing is done with a signal spectrum identical to that present in actual operation. A momentum-selective extraction process at Loma Linda could cause the bunch length and therefore signal spectrum to change during the extraction interval at the same time as the ring beam intensity diminishes. It was noted that the original CERN LEP BPM system manifested a systematic measurement error due to the presence of signal frequencies from the beam which had not been accounted for during the design and testing of the electronics.

Steve Smith showed transparencies of the PEP-II BPM circuitry including couplers on the beam signal inputs to facilitate "on-line" calibration. There was discussion of the operation of that calibration system and questions regarding its accuracy. Steve's presentation of one or two transparencies greatly facilitated discussion on the topic, and attendees of future discussion groups should be encouraged to contribute such visual enhancements.

Gianni Tassotto of Fermilab mentioned the potential need for a one-meter diameter beam current toroid for the Fermilab NUMI experiment. The transformer would measure secondary beam current downstream of the production target in the vicinity of the focusing horn. There was a short discussion about the possibility of such a large device and how to deal with its potential sensitivity to electrical noise from the high-current pulsed horn and to stray particles or beam halo that might intercept the toroid itself.

Active discussion continued right up to the end of the allotted time. About two dozen people had ultimately shown up to participate. No earthshaking conclusions were forthcoming but there was a good sharing of experiences, problems, solutions, problems to avoid, and diagnostic methods. The session closed with participants restoring the table and chair arrangement in the room to the state we found it.

Challenges in Beam Profiling

Marc Ross, SLAC

Three types of beam profile monitor were picked for discussion of design challenges:

1. Ion- and residual gas-based proton synchrotron monitors.
2. Phosphor screen monitors.
3. High resolution wire monitors.

J. Zagel presented a summary of the FNAL program to improve the performance of the micro-channel plate (MCP) based ion monitor. The calibration/aging of the MCP is a challenge. They are considering the collection of electrons instead of ions. This device, of which there are several dozen in existence, is clearly the best way to check the beam profile in a medium energy proton synchrotron. Use of electrons instead of ions, pioneered at BNL, removes the requirement for very high voltage. Resolution is limited due to broadening during the drift to the collection electrode. Typical resolution for this device is a fraction of a millimeter, appropriate for such machines.

On the phosphor screen topic, W. Graves of BNL showed results from doped YAG disks. We discussed the optics of the monitor and tried to estimate depth of field and other resolution degrading effects. The material may have an intrinsic resolution of close to 1 μm, but its thickness and associated imaging problems will make it hard to realize performance below 8 μm. The BNL material is 0.2 mm thick.

On our final topic, M. Ross showed the performance of the SLC laser-based profile monitor. J. Frisch provided presentation material concerning the development work for the future laser-based profile monitors with very good resolution. The purpose of the laser-based profile monitor is to allow monitoring of very small, high charge density beams. Conventional wire scanners, using carbon, tungsten, or silicon carbide wires will not work adequately for beams smaller than 1 μm, or beams with particle density greater than $1\times10^{10}/\mu m^2$. These limits have been tested at SLAC. Other wire scanner challenges include motion control, wire supports and scattered radiation detectors.

Feedback Systems

Mario Serio, LNF-INFN

The discussion session was held in the main Auditorium and attended by about 30 people with a good representation of accelerator laboratories from the U.S. and from the rest of the world.

No request of advice on specific topics was asked by the audience and nobody but the Chairman had transparencies or other material to present. In spite of this and of the usual shy start-up of this kind of session, especially in a large auditorium, the discussion became very lively with many interesting contributions which enabled the mutual clarification of different terminologies and points of view.

At the beginning of the session, a short time was spent commenting on the accelerator-oriented definition of feedback, which differs from control theory’s definition of returning a fraction of the system output to its input in order to maintain prescribed relationships between selected system variables. In fact, there was general agreement on an alternate definition of feedback as the technique (or the art) of exploiting the natural tendency of accelerator beams toward misbehavior in order to produce beneficial corrective actions. The most spectacular example of this is the stochastic cooling of (anti)proton beams, which leads to an apparent violation of the Liouville theorem.

The discussion was organized in matrix fashion, ordered by different families of feedback systems: longitudinal, transverse, position/orbit control and closed loop control of beam parameters and, for each family, by:

- Identification of suitable observable signals, detector noise rejection, common mode rejection, signal/data processing, speed of response (or, “How fast is fast?”).
- Identification of suitable corrective actions, choice of power amplifier, actuator noise, kicker issues, magnets issues.
- Requirements, system configuration and necessary gain.
- Merits and demerits of time domain (bunch by bunch) vs. frequency domain (mode feedback), and, for orbit control, local vs. global correction.

It was pointed out that if an offending cause is known a-priori, it may be possible to remove it. In any case, the realization of a suitable specialized feedback system may be simplified to a large extent by a detailed knowledge of the offending mechanism.

On the other hand, if a feedback system is conceived during the design stage of an accelerator, a tendency to design in greater flexibility may result in excessive system complexity. However, such a system generally pays off in terms of redundancy and diagnostic capabilities.

Interesting examples of the two extremes were, among others, the implementation of a specialized loop (CESR) for damping transients with a low duty cycle, constant amplitude pulser and of a DSP based longitudinal bunch by bunch system (PEP-II, ALS, DAFNE).

Given the high feedback gain generally specified, feedback builders often face the problem of how to get rid of any useless common-mode signal present in the front-end before amplification and data treatment in the subsequent stages. For example, walk of synchronous phase along the bunches of an uneven fill in a longitudinal system, or stationary orbit in a transverse one, may easily lead to saturation. In similar cases, as pointed out by J. D. Fox (SLAC), speaking of DC rejection or "notching" at revolution harmonics is only a matter of taste, or of terminology, but is truly equivalent.

In practically all of the synchrotron light sources it is necessary to rely on a closed stabilization loop of some kind. While at Elettra (Trieste) the beam lines are equipped with local loops, at APS (Argonne) a global system has been implemented. In the Elettra system, additional loops tuned to harmonics of the main frequency are able to reduce the residual beam motion up to high frequencies. An overview of the APS system was presented earlier during an oral session at this Workshop.

Eddy currents in the vacuum chamber shield the magnet corrector field and ultimately limit the frequency response of the orbit loops. Modeling and compensating the eddy-currents effect in the control loop transfer function is not trivial. The obvious cure is to reduce the vacuum chamber thickness at corrector locations as much as practical.

Moreover, it was pointed out that in pulse-to-pulse systems, such as those in linear colliders, the effectiveness of feedback systems is impaired by the lack of a suitable model.

In conclusion, this session gave the opportunity to several experts to confront their experiences and to some newcomers to approach the fascinating subject of accelerator feedback. All participants contributed to a lively and interesting discussion.

4th Generation Light Source Instrumentation

Alex Lumpkin, APS

This working group was a follow-up to the opening discussion, Challenges in Beam Profiling. It was run in parallel with the Feedback Systems session. We filled the SSRL Conference Room with about 25 participants.

The session opened with an introduction by Lumpkin. The target beam parameter values for a few-angstrom, self-amplified spontaneous emissions (SASE) experiment and for a diffraction-limited soft x-ray storage ring source were addressed. Instrument resolution would need to be 2–3 times better than the value measured if possible. The nominal targeted performance parameters are: emittance (1–2π mm-mrad), bunch length (100 fs), peak-current (1–5 kA), beam size (10 mm), beam divergence (1 mrad), energy spread (2×10^{-4})= , and beam energy (tens of GeV). These are mostly the SASE values; the possible parameters for a diffraction-limited soft x-ray source would be relaxed somewhat. Beam stability and alignment specifications in the sub-micron domain for either device are anticipated.

Vinod Bharadwaj (SLAC) then presented the specific design parameters for the LCLS SASE project at 15 angstroms (0.8 keV) and 1.5 angstroms (8.2 keV) using beam energies of 4.5 and 14.4 GeV, respectively. Roger Carr (SSRL) presented comments on the undulator and beam-based alignment techniques for the LCLS. Since the BIW'96 meeting, the strategy of steering and making position measurements every few meters between undulator sections has been accepted. Vinokurov pointed this out in the APS SASE design, and it was confirmed by adjusted calculations by Kim at LBNL for the LCLS. This revised strategy reduced the instrumentation challenges over the 100 m length undulator for keeping the photon beam and particle beam adequately in line. The overlap of the beams should be held to about 5 mm over 10 m.

Transverse beam size measurements were then discussed. Alex Lumpkin (APS) presented the results of using a 3.5 m long diagnostics undulator with the 7 GeV beam to measure a particle-beam divergence of 3.3 μrad. The fundamental radiation was at 0.5 angstroms (26 keV), close to the 4GLS wavelength. The technique should scale to the 1 mrad regime and possibly to a single, few nC micropulse charge. Lumpkin proposed such a device as one line of the array of undulators at an eventual 4GLS user facility. Additionally, the x-ray pinhole imaging technique with an x-ray streak camera was shown to measure tens of microns with projected 1 ps (sigma) resolution in an earlier presentation. The issues related to signal strength for slices of the micropulse at sub-ps regimes remains an area for development, but the transverse size averaged over the micropulse seems to be solved.

The discussion moved to the measurement of sub-picosecond microbunches. In particular, the temporal profiles at the sub-100 fs regime are an issue. Most of the correlation methods using coherent transition radiation (CTR), coherent diffraction radiation (CDR), coherent Smith-Purcell Radiation (CSPR), or coherent synchrotron radiation (CSR) will provide a measure of pulse duration. The temporal profile is much more ambiguously determined and often relies on an assumed shape. William Graves (BNL) commented on laser gating of a material's transmission or reflection property to provide sampling of converted visible radiation from the particle beam, e.g., an OTR signal. This could work at the 100 fs level with a ultra-fast laser probe. Other laser-based techniques have been suggested. As a side note, the differential optical gating (DOG) technique has been demonstrated recently at the Stanford FEL by Schwettman, Smith, et. al. Temporal profiles on the sub-ps domain were obtained although not on a single pulse. Still, the technique avoids phase-jitter averaging effects, so it can be used over many pulses. Development still proceeds for the x-ray streak camera at the 100–200 fs (sigma) regime. This has the potential for longitudinal profiles with a spatial profile (submicropulse) as a complementary approach.

The discussion moved to the task of maintaining the photon beam and electron beam overlap to a few microns over a gain length of a few meters. (In the LCLS case this is 5 mm over 10m.) Suk Kim (APS) presented the rf BPM button configuration that is planned for the APS visible/UV SASE project. By rotating the axis of a pair of 4 mm diameter buttons, very high sensitivity to motion in one plane is calculated which should scale to sub-micron resolution. Tests are expected in the coming year. An LCLS person brought up the combined electron and photon beam diagnostic based on the interactions with a single, 10 to 30 μm thick carbon wire. Photons are diffracted to an x-ray detector positioned off-axis at 25.8° to the particle beam direction, and the bremsstrahlung radiation is detected by another detector at a more forward angle.

As the session's allotted time was over, we adjourned to allow further discussion among small groups. The challenges in the spatial, temporal, charge and position domain plus the preservation of beam quality were duly noted.

High-Performance Beam Position Monitor

Steve Smith, SLAC

This discussion group met in the auditorium as a plenary session of the Beam Instrumentation Workshop. The first topic was to identify what we mean by "high performance" in the context of beam position monitors (BPMs). Areas of interest included precision, accuracy, sensitivity, bandwidth, data rate, data reduction capability, maintainability, performance per unit cost, stability with respect to beam intensity, and mechanical stability.

Don Martin from SSRL presented a list of required parameters for the LCLS (Linac Coherent Light Source) beam position monitors to stand as an example of BPMs that require high performance in several aspects. The system must be consistent with the specifications in the following table:

Parameter	Value or Requirement	Comments
Repetition rate	120 Hz	
Bunch length	$\sigma_z = 0.15$ ps	
Peak current	I = 4 kA	
Resolution	< 1μm rms	@ 1 nC/bunch
Repeatability	< 5 μm	over hours
Accuracy	< 50 μm	

PThis started discussions on several topics, principally concerning the need for beam-based alignment (BBA). Jim Hinkson (LBNL) commented, "We must build in beam-based alignment from the beginning." Absolute accuracy requirements become untenable if one tries to build accuracy into (or calibrate it into) the instrumentation. Herman Schmickler (CERN) warned, however, that it takes months to get a machine ready for beam-based alignment; one can't count on beam-based alignment to get a machine working. Steve Smith (SLAC) added that there are capture tolerances for accuracy before getting BBA. Glen Decker (Argonne) seconded Hinkson; one must build in BBA. Douglas Gilpatrick (Los Alamos) noted "If you have stability and resolution, you can figure out absolute alignment." He added that when specifying stability, it is always with respect to a time period and a length scale. For example, one person's resolution may be another's accuracy due to differences in time scales. Bob Hettel commented that, for FELs, there is an additional requirement for the photons to be aligned with the electrons.

The discussion turned to the benefits of single-channel switched receiver vs. parallel receiver designs. Julian Bergoz stated "Resolution is easy. Stability with respect to beam current is hard. Accuracy is intermediate in difficulty." Hinkson added "Stability with respect to fill pattern is difficult, too." Schmickler asked that, for comparison purposes, one should "specify resolution as a fraction of aperture, so we can translate between very different geometries." Hinkson added that users care about stability in terms of fraction of beam size, saying "they don't know how big the pipe is."

Manfred Wendt (DESY) then presented requirements for BPM's to be used in an FEL undulator in the Tesla Test Facility. The system must meet the requirements outlined in the following table:

Parameter	**Value or Requirement**	**Comments**
Bunch charge	0.5–1.0 nC	per bunch
Bunch spacing	111 ns	9 MHz
Pipe size	10 mm	diameter
Pickup elements	tiny fingers	
Signal spectrum	rising to 4 GHz	
Resolution	< 5μm rms	average over 7000 bunches

Wendt asked the group how might they read this out with limited time and manpower. He proposed using an AM/PM monopulse receiver in the style of Vismara and Cocq with a 200 MHz low-pass filter. Glen Decker suggested a log-ratio system consisting of bandpass filters, downconverters, log-amps, and difference amplifier. Bob Shafer (Los Alamos) commented "It's not well known that AM/PM and log ratio techniques have poor noise figures."

A lively discussion envolved many participants on the question "Is it better to have striplines terminated or shorted?" The cost and reliability of extra feedthroughs were discussed as reasons to not terminate striplines. Warnings were issued about filter response surprises and unexpected amplifier noise when working with unmatched sources. Several stories of open vs. shorted striplines ensued.

The possibility of another type of BPM, based on acoustic waves propagating around a conducting beam chamber wall was brought up and briefly discussed. We had no difficulty in consuming the time allotted for discussion.

Closeout Discussion and BIW Y2K

Steve Smith, SLAC

The 1998 Beam Instrumentation Workshop ended with the traditional closeout session, where, after acknowledging those who made the Workshop successful (see preface), we attempt to identify our strengths and weaknesses, and poll the attendees for suggestions to improve future Workshops.

The discussion groups generated substantial comments. The discussion group format is popular, but a common complaint was voiced about the difficulties in getting full participation in a discussion group held in an auditorium; a smaller room with participants facing each other is more conducive to discussion. A suggestion was made that each participant be asked to bring one slide, presenting a problem they want to have solved, in order to get discussion going.

Publication on CD-ROM was suggested, as was a request to keep publication on paper. The consensus was that the Proceedings should be available at least on paper, CD-ROM publication could only supplement paper. A participant suggested that the publisher of the Proceedings, the American Institute of Physics, be invited to send a salesperson to the next workshop along with a stack of the Proceedings of earlier Workshops, as the back issues are always in demand.

Several topics for future tutorials were proposed. Tom Shea suggested one tutorial on “Grounding, Shielding, and Isolation” for instrumentation and another on magnetics, magnetic shielding, and magnetic sensors (such as Hall effect and NMR probes). Keith Jobe also suggested two topics, one on “Lasers, and how to use them as a diagnostic tool”, and another on “Radiation Practices in the Tunnel”, i.e. how to build things that must live in the machine. Julian Bergoz suggested “Beam vacuum interaction mechanisms” as a topic. Robert Merl suggested, since beam instruments are becoming increasingly complicated devices, often containing dedicated processors, a “DSP Tutorial” would be in order.

Bob Averill, BIW Organizing Committee member from MIT-Bates Laboratory, announced that the next Beam Instrumentation Workshop, BIW 2000, will take place in Cambridge, Massachusetts. The Massachusetts Institute of Technology (MIT), the Laboratory of Nuclear Science (LNS), and the Bates Linear Accelerator Center (BLAC), will host the Workshop on the MIT campus. Bob presented a brief overview of the MIT facilities and the Boston area, inviting participants to attend BIW 2000 and to experience this fascinating and historic region.