The E158 Status Review Report

SLAC - September 21, 2001

Steve Williams called for a status review of the E158 experiment on September 21, 2001, at SLAC. The purpose of the review was to determine what significant problems were encountered in the Spring 2001 engineering run, what fixes are underway, the probability that the upcoming April/May scheduled run will succeed, and what fraction of the original proposal would be accomplished in the scheduled run.

The Committee was chaired by Charles Prescott, with the following committee members: Stan Ecklund, Roger Miller, Peter Rowson, Sayed Rokni, Dave Schultz, and Bruce Schumm. All members are from SLAC, except for Bruce Schumm, from UCSC. The Charge to the Committee and the schedule of talks are appended to this report.

SUMMARY AND RECOMMENDATIONS

Overall, the Committee's impression is that E158 is in pretty reasonable shape, and that the likelihood of E158 achieving its goals for the April/May run, given a commitment of the Lab to support some of their improvements, is reasonably high.

The E158 experiment proposes to make a precision measurement of the electroweak mixing parameter $sin^2\Theta_W$ in the elastic scattering of electrons. The kinematics of high energy electrons scattering from quasi-stationary target electrons gives a measurement at low center-of-mass energy, far away from the Z-pole. The original proposed goals of the E158 experiment can be summarized in terms of the error on the electroweak mixing parameter, $\delta sin^2\Theta_W = \pm.0007$ (Note: the world average is now $sin^2\Theta_W = 0.23156 \pm 0.00017$ at the Z-pole). The E158 collaborators expect to achieve $\delta sin^2\Theta_W = \pm.003$ in the upcoming April/May run. This accuracy assumes 4 weeks of running at each of two energies 45 and 48 GeV, 30% efficiency in delivery of beam on target, and a charge of 2×10^{11} per pulse. This Committee was asked to review the status of E158, and the likelihood that the stated goal for the April/May run could be achieved.

The issue of detector resolution was central to these discussions. E158 define their raw "signal" to be an asymmetry in S/Q (where S is the integrated detector signal and Q is the beam charge as measured with the toroids) between accelerator pulse pairs of opposite helicity. Starting from this signal, the beam contributions are removed by a regression analysis. The width of the resulting distribution was seen to be $\approx 5 \times 10^{-4}$. This resolution should be set by counting statistics, which happens to be around 2×10^{-4} for the running conditions in the engineering run. Thus, in the engineering run E158 observed this resolution to exceed the statistical limit by a factor of 2 to 2.5, on the average. Beam monitors, on the other hand, appeared to meet or exceed the noise requirements. For the upcoming April/May run, they make an assumption of modest improvement (ie., reduction) in the resolution from what they achieved in their engineering run. Given success with modest improvements, then this Committee believes that E158 has a good probability of achieving the $\delta sin^2\Theta_W = \pm.003$ level in the April/May run.

The main obstacle to achieving the desired goals for April/May are in manpower support. Both E158 and SLAC are under pressure to accomplish the needed work on the short time remaining before the next test. Installation of a set of new collimators is the highest priority. Next, E158 wishes to install a skew quad before the next run, but the technical studies have not been completed for the skew quad modification of the A-line. Installation of the skew quad requires access to the A-line while the accelerator is off. The work on phototube linearity appears to be incomplete. On the accelerator side, a number of problems having to do with PEP II limit the stability and quality of the linac beam.

Achieving the assumed improvements requires strong support from the Accelerator Division, strong engineering support, access to the linac for A-line modifications, and access to the shops. The Committee notes that there are potentially serious conflicts with PEP II in the areas of manpower, shop access, accelerator physicist support, and access to the linac for modifications. These conflicts may limit the amount of work E158 can get done, and therefore undermine the improvements and resulting accuracy they achieve for the April/May run period. It is essential to the success of E158 that their needs be supported by SLAC and that they be accomplished in a timely way.

The E158 Collaboration has a list of items, resulting from the tests and engineering run, that are needed to control the beam jitter and backgrounds they experienced. Some important items are briefly discussed here. More details are given later in this report, where individual systems are discussed.

E158 is preparing an additional set of seven collimators to place downstream of their spectrometer quads. The seven collimators are situated so as to intercept photons that bounce off the upstream collimators. The resulting geometry is "two bounce" optics, ie., requiring that photons which scatter off primary collimators must not have direct line-of-sight to reach the detectors. The earlier beam tests gave them reasonable indications that this problem was the main contributor to the detector noise. The set of collimators are tungsten collars, fabricated outside of SLAC. These collimators must be installed in beam line assemblies. Completion of the beam line assemblies is still needed. Their schedule shows installation and alignment in November (over Thanksgiving). Will this work get done on time?

E158 argue the need for a skew quad to be located after the A-line bends, as part of the beam line optics. The skew quad mixes beam x and y at the target and therefore increases the y emittance significantly from synchrotron radiation emittance growth in the switchyard. This should significantly reduce the vertical beam spot sensitivity to jitter and drifts in the linac.

Installation of the skew quad is a high priority item for them. Since the E158 optics studies are not finished, the studies should be finished and these studies should be reported back to this Committee on this single item when ready.

In addition to these two main items, E158 has other issues that are not yet resolved. Items include the linearity of the detector phototubes and electronics, electronic noise in the phototube readout, accuracy of the Moller polarimeter, and backgrounds in the detector and luminosity monitoring systems. More work on these will be needed to achieve the ultimate E158 goals.

The ability of the accelerator to deliver stable high quality beams to the ESA has been allowed to degrade. The injector polarized gun has several problems, that need attention. The cathode needs renewal, which can be done, but requires several days access for the work. The gun HV is unstable, and is being operated below design (110 KV instead of 121 KV). The gun should be brought back up to the operating voltage. Franz-Joseph Decker stated that the Control Room lacks accelerator physicists who understand the long pulse linac operation. Turn on of the ESA beams is a heavy burden on himself and Jim Turner, and he needs more help than he is getting. The Accelerator Department should be asked to give higher priority to the planning and turn-on of E158.

The MDL interferometer performance has been degraded by changes made in the linac trigger system and RF drive system to facilitate filling many buckets in PEP II. The MDL interferometer should be resurrected.

Dispersion free steering needs to be activated again, to control the beam jitter in the linac.

All of these accelerator issues impact with varying degrees the E158 probability for success in the next run period. These control features were developed and used during the era of the SLC. It seems that they have been allowed to fall by the wayside in the PEP era that has followed. The Accelerator Division should be expected to maintain these capabilities, even if PEP doesn't need them.

DISCUSSION

In the following paragraphs, we discuss individual systems presented to us in the Review.

E158 Experimental Goals for the April/May Run

The E-158 program goal, slightly relaxed compared to the original 1997 proposal, (SLAC-Proposal-E-158, July 17th, 1997) can be stated as an error on the weak mixing angle of ± 0.0008. As originally conceived, an ultimate statistical error on the measured left-right asymmetry of 7.5% was anticipated, and the leading systematic errors were polarimetry (3%), backgrounds (1%) and momentum (Q^2) scale (1%). The present state of affairs as presented in this review is somewhat less ambitious, as will be discussed below.

The running plan that was presented includes a 2002 run in April and May that will be very important for the E-158 experiment. For this next run, the collaboration anticipates a fairly wide range of possible total luminosity (over a factor of 3.3), depending on beam current performance and running efficiency.

In the E158 review, two scenarios were presented, a "pessimistic" and an "optimistic" one. In the "pessimistic" scenario, bunch currents of 2×10^{11} and running efficiencies of 30%, which were achieved in the engineering run, are assumed to be reached again and a total statistical error of 29% (relative to the expected asymmetry) is attained. Alternatively, higher currents (bunch currents of 3 and 5 $\times 10^{11}$ for 48 and 45 GeV, respectively, and improved efficiency (50%) would lead to a statistical error of 16%. In the former case, already demonstrated systematic uncertainty would suffice. *It is, however, extremely important that significant gains in systematic error control be demonstrated in the upcoming run, as even in the optimistic case the ultimate experimental goals of E-158 would not be approached in the 2002 run and a second run would be essential.*

The systematic effects seen in the engineering run, and assumed in the pessimistic extrapolation for the 2002, were 5-10% due to polarimetry, 10% due to backgrounds and 5% momentumn scale effects - all well above hoped for levels.

The most significant issue appears to be a much larger than expected background, and the collaboration presents a plausible argument that this background is due to photons at small angles. Two modifications to the experiment for the 2002 run that should alleviate this problem have been proposed: the addition of a skew quadrupole magnet that should reduce sensitivity to spotsize fluctuations at the hydrogen target and to beam tails in the linac, and the addition of collimation downstream of the target. Outstanding issues associated with the skew quad proposal are discussed elsewhere. The effectiveness of collimators must be demonstrated in the 2002 run if any additional running of E-158 is to be useful.

The issues of Moller polarimetry were somewhat unclear. The goal of 3% uncertainty on the beam polarization is a reasonable one that has been achieved by A-line experiments in the past. Backgrounds, in part due to PMT noise, were a problem in the engineering run, and a new Moller polarimeter detector is being built. There is a fair amount of work to do here, and presently documentation (in the form of E-158 memos) is lacking. While 5-10% polarization precision is sufficient for both 2002 run scenarios, it would seem to be rather important to demonstrate performance close to the design goal during this run in order to better motivate further data taking.

Beam monitoring and left-right asymmetry control appear to be in fairly good shape, and while modest improvements are desirable, the group has concrete plans to achieve these goals and these issues are unlikely to present a limiting systematic effect.

The hypothetical 2003 run would be 3 1/2 months of data taking at high efficiency, and with the ultimate performance discussed above would be able to attain an error on the weak mixing angle of ± 0.0009. The goal of the experiment (± 0.0008) could then be reached if the 2002 run provided a precision of better than roughly ± 0.003. An effort to improve running efficiency in the 2002 run up to the level of 70% was mentioned in the review and this approach deserves serious attention. In addition, it would be prudent to investigate the possibility of extending the 2002 run into June if costs are manageable and good performance had been achieved in April/May.

Detectors

The E158 detector system consists of four components. A calorimeter composed of copper plates and quartz fibers instruments the radial region between approximately 15 and 35 cm from the beamline. The inner portion of this detector measures the Moller region between 15 and 25 cm, within which the spectrometer focusses the Moller scatters between approximately 4 and 8 mrad in lab scattering angle that are selected by the annular acceptance of the 3QC1B fiducial collimator. The outer regions of the calorimeter measures the corresponding flux of elastic e-p (Mott) scatters. An annulus of ion chambers at approximately 1 mrad from the beam axis intercepts a large flux of low-Q^2 e-p scatters, and is intended to track luminosity fluctuations as well as to provide a control measurement with an expected null asymmetry. A movable profile monitor, incorporating quartz crystal flux counters and segmented scintillation pads, allows for the precise mapping of the shapes of the Moller and Mott signals in the detector region. Finally, a shielded quartz bar detector backing up the Moller region of the calorimeter serves to monitor the flux and asymmetry of pions from inelastic e-p scatters.

During the engineering run in Spring, 2001, the profile monitor observed abundant electron coincidences in the kinematic region of Moller scattering, showing clear evidence for the Moller signal. However, mapping of the signal profile with a collimator (QC1A) restricting all but a very narrow slice of scattered phase space yielded substantial disagreement with Monte Carlo expectations. There is reason to believe, though, that the discrepancy may be due to problems with backgrounds, and appropriate modifications are being made to the phototube readout of the quartz profile monitors. While probably not essential to the success of the program, the information provided by a fully functional profile monitor would provide an important check of the modeling of the transfer and focussing properties of the spectrometer.

Data taken in the main calorimeter and luminosity monitors were beset by substantial backgrounds, whose fluctuations dominate the statistics of the asymmetry calculation. In the case of the main calorimeter, this limited the pulse-pair asymmetry width to $4-5\times10^{-4}$, whereas the width expected from statistics alone, given the 2×10^{11} electrons on target per pulse, was approximately 2.5×10^{-4}. The asymmetry width observed in the luminosity monitor was similar to that of the main calorimeter, compared in this case to an expectation of approximately 1×10^{-4}.

In the case of the main calorimeter, this background provides a substantial degradation of the statistical power of the accumulated data. In the case of the luminosity monitor, the quality of the null asymmetry calibration is compromised. To the extent that luminosity fluctuations are due to the $\sim 10\%$ fluctuations of the spot size at the target, a upper limit of 2×10^{-4} on the contribution to the pulse-pair asymmetry was set by studying the average luminosity versus spot size. This limit would not apply if the spot size fluctuations increased in magnitude, or if luminosity fluctuations were caused by effects other than those related to spot size.

Analysis of the pattern of statistical correlation as a function of azimuth independently in both systems, as well as the response of blinded tubes in the main calorimeter, suggest that the background is due to an isotropic flux of neutral particles originating upstream of the detector region (a so-called "common mode" background). The distribution and behavior of the background can be modeled, at least qualitatively, in terms of showering off of the collimators of the spectrometer system. The collaboration has proposed the inclusion of several more collimators within the spectrometer, which will substantially reduce the background to the detectors if this model is correct. In addition, improvements to the beam quality, including the coupling of the x and y emittance with a skew quad, and the development of dispersion-free steering, may well reduce the fluctuation of the background. The likelihood of reducing the effects of the detector backgrounds in this way seems fairly high, although the resulting degree of improvement in the pulse-pair asymmetry width is a matter of some speculation. In the main detector, the background fraction depends upon distance from the beamline, and is as large as 20% for some of the innermost detectors.

Another factor which degraded the pulse-pair asymmetry width in the main detector during the engineering run was electronic noise. With an rms of approximately 5 counts out of a signal of $\sim 2 \times 10^4$ counts, this contributed roughly

3×10^{-4} to the asymmetry width for a single channel, but the noise is incoherent across different channels and the contribution to the cumulative width is 1×10^{-4}. However, it was observed that the noise dropped to an rms of 0.5 counts when the high voltage to the phototube bases was disconnected. Thus, it seems that this problem will be relatively straightforward to cure.

The linearity of the phototube signal also presented a problem during the engineering run. In an experiment such as E158, with tiny pulse-to-pulse fluctuations in signal size, the error in the overall asymmetry scale caused by non-linearity is essentially given by the ratio of the slope of the response function in the signal region to that for small signals. The goal for E158 is that these should be the same to within 0.5%, whereas differences on the order of 10% were seen in the engineering run. However, it is anticipated that this problem will be readily overcome. Several ideas were put forth regarding the enhancement of the linear range of the phototube response. In addition, if the pedestal noise is substantially reduced, it will be possible to lower the phototube signal size and retreat from the non-linear regime. Switching to a more linear phototube design is also a possibility, as is, as a last resort, the calibration of the individual tubes' response curves. It seems unlikely that signal linearity will remain an appreciable issue when the high-rate running commences in Spring 2002.

There was some discussion of the addition of one or more gas Cerenkov devices in the luminosity region. Gas Cerenkov counters have a high threshold, and may well be insensitive to much of the background observed in the luminosity system. An effort would have to be made to procure such a device, as no specific design exists at this point. This might prove a valuable hedge against the possibility that prejudices about the source of the background turn out to be wrong. However, because the backgrounds in the luminosity system have been observed to be uncorrelated with those in the main detector, this would not address the issue of the dilution of the Moller asymmetry measurement.

Finally, we heard that the Moller polarimetry precision was expected to be around 10% for the April/May run, while the proposal specifies ultimately that this precision be around 3%. The Committee believes that the 10% value is adequate for the April/May 2002 goals, but E158 should demonstrate better precision than that if further running (ie, in 2003) is to be effective in improving the precision. E158 should consider Moller polarimetry with more than one foil thickness.

Other concerns that were briefly mentioned are the Q^2 calibration of the detector, which if in error, affects the comparison with theory, and the larger than anticipated irreducible background from the radiative tail of inelastic *ep* scattering. Understanding of these issues will be needed before proceeding to a 2003 run.

Linac Issues for E158

There are basically two issues in the linac for E158: 1) Improving the beam quality; 2) Improving the beam delivery efficiency, i.e. the percentage of scheduled beam which is actually delivered to the target. These two issues are not cleanly separated but the division is still a useful concept and will guide this discussion.

1) Beam Quality includes beam intensity, energy spread within each pulse and pulse to pulse jitter in intensity, position and energy. There is a discussion elsewhere on improving the intensity and decreasing the jitter of the beam coming from the Polarized Electron Source. The most important issue in beam quality is, because of the heavy beam loading (8.5% to 15% for 4.5 to 6.5×10^{11} e^-'s), the intensity jitter from the source, which induces energy jitter through the linac. Because there tends to be residual dispersion in the linac the energy jitter produces position jitter at the end of the linac. This effect probably dominates the position jitter at the end of the linac. Fortunately, there is an effective cure for this source of position jitter, namely, Dispersion Free Steering. Indeed during the 2001 run a simplified form of dispersion free steering was used and reduced the jitter by as much as an order of magnitude. The pulsed steering in Sector 1 was used to induce a betatron oscillation in the linac from sector 1 to sector 20 which approximately cancelled the residual dispersion in the linac. The short coming of this approach is that it does not cancel the dispersion locally, so that as the betatron phase advance in long sections of the linac drifts over time the cancellation deteriorates. The software for dispersion free steering should be upgraded to reflect the existing hardware in the linac as required and including a case where only pulsed steering in sectors 1 through 10 and DC steering in sectors 20 through 30 is permitted to be adjusted. This would permit optimizing the Dispersion Free Steering for the E158 beam periodically without affecting the PEP beams. A very important action which will improve both the average beam quality and the beam delivery efficiency is fixing the main drive line interferometer which has been inadequate since the beginning of operation of PEP II. The interferometer is intended to keep the phase shift of the RF power in the main drive line from Sector 0 to sector 30 constant as the ambient temperature and the atmospheric pressure in the Klystron Gallery change. Mark Ross says he believes the present interferometer should be compatible with PEP II, but may require some trigger timing adjustments. As the main drive line phase undergoes diurnal drifts the energy contributions of klystrons vary, changing the betatron phase advance in the linac which will disrupt the dispersion free steering. This requires more frequent tuning of the beam.

2) Beam Delivery Efficiency depends on many factors such as how well PEP is running and how difficult the beam quality requirements of the E158 are to maintain. The one sure fact is that any system that improves the ability to tune one beam without affecting the other beam will help, unless the system degrades

the quality of the some beams significantly. The most important hardware for improving the Beam Delivery Efficiency is pulsed steering within the first 10 sectors where the PEP positron beam, PEP electron beam, PEP scavenger beam and the E158 beam coexist. A number of pulsed steering dipoles and their power supplies still exist from the days before SLC when as many as 12 interlaced beams were run at one time. These need to have the power supplies refurbished and be moved to strategic locations in the first 10 sectors. They need to be integrated into the SLC magnet database and the SLC Control system. How many can be available for the spring 2002 run is not clear at this time. What is clear is that having 4 to 6 pulsed steering pairs (horizontal and vertical) is strategically placed is very important. If E158, or another experiment with similar requirements, is to run in 2003, then the laboratory should aim for having a pulsed steering pair every 100 meters in the first 20 sectors. Pulsed quadrupoles are an entirely different story. There are close to 400 DC quadrupoles in a FODO array in the linac at 12 m spacing along most of the linac and at closer spacing in sectors 1 through 5. It is not clear that adding a small number of pulsed quads along the linac would do anything useful.

3) Simulations are a very important tool in accelerator physics and there a number which need to be done here to enhance both the E158 beam quality and the beam delivery efficiency.

a) A BBU Simulation would be very useful to understand whether it will pay to try to increase the intensity a factor of two or whether it makes better sense to concentrate on improving the stability and beam delivery efficiency at the intensity run in April and May, 2001. We have a lot of experience with dipole wake calculations, the necessary software exists and should give quite good answers.

b) Beam Dynamics Simulations are needed to find an optimum quadrupole lattice for compatible operation of the 3 PEP beams with the E158 beam and what energy profile works best for the PEP beams.

c) Dispersion Free Steering of the E158 beam needs to be simulated first with all the DC steering and then simulation of maintaining low dispersion with just the pulsed steering as the energy profiles drift over time. Software for implementing dispersion free steering in the linac also needs to be developed.

4)For running at 48.9 GeV, we heard that there are only few spare klystrons (two or four). This energy should be tested before going to 120 Hz.

5) (Conclusion) If at least 6 additional pulsed steering pairs can be in place, if the new cathode produces 50% more current, and if software required for dispersion free steering is completed for the spring run, we think the E158 spring 2002 run can achieve intensities between 3 and 4×10^{11} and beam delivery efficiency from the linac as high as 70%. This efficiency assumes that PEP has a nominal run without an excessive number of beam dumps requiring more frequent fills or trouble filling which requires long fills.

Target

The E158 target is an advanced LH2 design capable of absorbing high beam power. The target is a circulating flow which passes over a heat exchanger cooled by He gas. Approximately 1.5 meters in length, it handles up to 1 KWatts of heat loading due to the beam. To maintain a level heat load, a heater in the circulation loop is turned on when the beam loading goes away. The target has undergone a series of venting events. These have been largely solved, and the reliability of the target has improved considerably.

The flow is not laminar. Considerable stirring of the liquid occurs due to screens in the flow path. Considerable concern over "density fluctuations" has existed. Density fluctuations lead to signal fluctuations which broaden the distribution of the detector's integrated charge per pulse. The specification for this is $< 1 \times 10^{-4}$. E158 has not seen any effects of density fluctuations, but sensitivity at this level is not yet possible until other sources of detector signal fluctuations are reduced first.

Tests for density fluctuations is expected be carried out. Varying the beam size, beam current, pulse rate, and fan speed are the tools to be used for studying these effects.

The target appears to be functioning reasonably well. Credit goes to John Weisend and the CalTech team, for a job well done.

Injector Systems

During the E158 run in 2001 the linac setup was difficult because the temporal profile of the electron beam coming from the gun could not be shaped. Beam loading compensation in the linac requires that the electron beam pulse current be nearly constant (gradually decreasing) and have adequate current so that the energy of the beam pulse can be held constant. To accomplish the electron beam pulse shaping, the laser pulse to the photocathode is shaped in time using the TOPS system. The TOPS system maintains the laser pulse temporal shape by throwing out excess power. This requires that the laser have enough initial power to allow the excess to be filtered out with sufficient power remaining to excite the required current from the photocathode. The photocathode used in the 2001 E158 run did not have high enough quantum efficiency to allow the TOPS system to be used. The resulting electron beam was therefore not properly shaped in time, leading to inadequate beam loading compensation and an energy tail on the pulse. For the upcoming run the Accelerator Department's Injector group proposes to use a new photocathode that uses a strained GaAsP active layer with a high level of doping at the surface to increase its quantum efficiency and eliminate the 'surface charge limit'. The higher quantum efficiency (30% increase) will allow the power from the laser system, which cannot be increased, to be high enough that the TOPS system can be engaged. Recommissioning the TOPS system will also require assistance from the software group. This will allow the electron source to deliver the high constant current needed for beam loading compensation, leading to lower energy spread and lower backgrounds in the E158 detector. The new photocathode delivers high polarization at a shorter wavelength (800 nm) than that used previously (850 nm). This requires that the laser cavity optics be retuned, by the Injector Group, to the new wavelength. The laser will also be tuned to minimize intensity jitter which is typically $<2\%$ RMS and has been as low as 1% rms. During the upcoming E158 run the current from the injector will more than double, from 3×10^{11} to 8×10^{11} electrons per pulse. This will be accomplished primarily by increasing the pulse length, which will now be practical because of the pulse shaping capability. The higher intensity will make the tuning of the injector more critical to establish beam stability.

Beam stability from the injector was made worse during the 2001 E158 run due to jitter from klystron K02. K02 had problem of multipactoring. The cause of this problem is unclear, so the correction is likewise unclear. However the K02 tube is essential and the jitter problem must be solved.

The high voltage of the photocathode gun during the 2001 E158 run was also unstable. The gun voltage had to be lowered to eliminate high voltage trips, and the gun is now running at 110 KV rather than the usual 121 KV level. Running at lower voltage degrades beam-bunching performance leading to lower injection beam quality. The gun is also operating with a 50/50 mixture of SF6 and dry air in the high voltage volume where running with dry air alone had been routine. The use of SF6 adds modestly to the cost of operating the source, and highlights the deteriorating high voltage performance of the gun, which has had a chronic and vexing problem with dark current. The Injector Group will address the gun's high voltage performance by replacing the guns cooling lines, a fiber optic and high voltage cables when the photocathode is changed. The spare gun, which could be installed if necessary, is presently operating in the Gun Test Lab without high voltage problems.

There are also issues in injector setup to address beam quality, which will be met by the Injector group. The energy tail of the beam could be tuned by taking the beam into the NLTR. This has been done before for high current beams, however the high current of the E158 beam raises concerns about machine protection in this beamline. The asymmetry feedbacks that control the laser spot on the photocathode take as a readback BPM signals from the ASSET area. This feedback can be made more sensitive by optimizing the phase between the photocathode and the BPMs. The transmission of the beam through sector 1 is not without losses, perhaps due to an energy tail. These losses need to be investigated. In addition there is steering feedback that needs to be recommissioned, helping to maintain good spot shape at the experiment and to keep wakefield problems from occurring. Finally, the toroids on the linac need to be recalibrated to aid in diagnosing beam loss.

Injector system personnel will be hard pressed to accomplish these performance improvements. The laser retuning, the gun recabling and the photocathode change must be accomplished without impacting the PEP2 program and are planned for the week after or before the Christmas break. Maintaining the tight performance tolerances on the source and the injector beamlines during the upcoming four-month E158 run will require an effort at the level of former SLC running but with a reduced staff. Recommissioning the TOPS and the steering feedback will require assistance from the software group as well.

Radiation Safety

The required shielding and Beam Containment devices for the E158 experiment were in place in the ESA for the Spring 01 engineering run. The results from the passive monitoring and radiation surveys show that a radiation safe environment was established and no significant problems were encountered.

At two areas, higher radiation levels than calculated were found. When scaled to full beam power and two months of operation, radiation levels in the ESA Counting House are expected to be a factor of 2 higher than the design values. The measured radiation level would be a factor of 4 higher than the design value in a small region of Building 131 in the SSRL as well. However, fixes have been identified and there are no requests for new shielding. To reduce the radiation levels in the counting house, the gaps between the lead shielding and magnets need to be filled by lead blocks. To reduce the radiation levels in the SSRL a concrete block will be added on the northeast end of the spectrometer. Also, leakage in the lead shielding at each spectrometer dipole and around the north side of the Luminosity Monitor will be blocked as per original request. Addition of 7 collimators in the spectrometer also has a minor consequence for radiation levels around the ESA and can be fixed by addition of one EX-1A shielding block. In general, only minor fixes in the ESA are needed for the high-power run to meet its radiation safety goals. The existing BCS instruments need to be carefully re-calibrated and checked since the average beam power will be increased ten fold.

Regarding the accelerator safety issues, a program is underway to place 16 inches of borax in bags in the linac penetrations to reduce the radiation levels at the top for the mis-steered beams to design values. The adequacy of this shielding and details of this program needs to be reviewed and approved by the Radiation Safety Committee before the start of the high-power run.

Skew Quad Added to the A-line

An improvement requested is the installation of a skew quad in the A-Line. This is to reduce the effects of vertical beam jitter (tails or y-emittance changes) at the experiment by coupling the larger x emittance (from A-Line synchrotron radiation) into the vertical.

E158 did not present a specific beam line optics, but did provide a study note which examined several proposed solutions rotating one or two existing quadrupoles. The accelerator department proposes not disturbing existing A-line magnets but moving a magnet from the B-Line, mounting it as a skew quad. This configuration has not been calculated to determine if it is a viable solution. Also this should be done before the considerable mechanical work is started.

The time available to install or rotate A-line magnets is only a few days in January; more time will likely be needed.