Comments on the Review of Neutrino Beam Monitoring
December 10, 2001

Responses by Bruce Baller
May 7, 2004

Introduction, Summary & Future
Presenter: S. Kopp

1. (Reviewer: B. Bernstein) The environmental variables are not well controlled. Measurements need to be made as close as possible to the devices, not something 20 feet down the corridor. The temperature at the monitor and in the alcoves will vary and perhaps I missed it but I believe no data were shown about the variation, although the standard equations were trotted out. A measurement would be helpful. These will be important particularly during start-ups. It is more than likely that these are the times when the temperature of the enclosures will vary.

OK

2. (Reviewer: A. Marchionni) It was stated that a beam position measurement accuracy of 3 cm is needed, but no specific design was presented. In particular it was not discussed how well we need to know the inter-calibration of the different pads to perform the measurement.

The 3 cm accuracy is readily achieved by standard alignment techniques. The inter-pad calibration was done to 1%.

3. (Reviewer: A. Marchionni) In the engineering of the muon monitors particular attention should be paid to the humidity conditions in the alcoves and to the cabling of the pads, in order to avoid the collection of additional ionization outside of the pad itself. Some more experimental tests will probably be needed here before proceeding to construction.

There are no obvious paths for humidity infiltration into cables or the monitors themselves. The relative humidity in the tunnel is ~50%.

4. (Reviewer: S. Wojcicki) I believe we should do the R&D on neutron irradiation up to the levels anticipated.

Done.

Physics Specifications
Presenter: D. Harris

On the muon system:

1. (Reviewer: B. Bernstein) Although significant progress has been made, the physics goals are not as sharply defined as I would like. The use of the hadron monitoring to establish initial beam position is well thought out but after that I don't see a convincing argument.

The primary purpose of the hadron monitor is to align the proton beam during commissioning. Other methods for monitoring targeting problems exist during operations, however the hadron monitor will provide some redundancy until it fails to function.

2. (Reviewer: B. Bernstein) The group presents a contradictory position on the hadron system. On the one hand the device is supposed to be worth building, but on the other it says that if something breaks it will not be fixed. Either it is worth having or not: if it is then some plan for repair or replacement has to be worked out both for the pads and for the readout.

The primary and secondary goals of the hadron monitor are explained above.

3. (Reviewer: J. Hylen) I would like to see the hadron monitors be replaceable. I suggest the cost-effective way to do that is to have a few small-profile rows sitting in trays or racks, where a single row could separately be extracted out the side into a small coffin.

We have decided that the cost of a replaceable hadron monitor is not warranted.

4. (Reviewer: J. Hylen) As discussed in the general comments, a propagation of specification of position accuracy to chamber response calibration should be incorporated in the hadron monitor specification document. I think this is needed before the calibration requirement can be understood for the hadron monitor.

OK

5. (Reviewer: A. Marchionni) At this point it is also important to quickly finalize the disposition of the PIC muon array, which has implications on the engineering of the system. Do we need chambers extending outside of the radius of the decay pipe? It is not yet clear to me the role of alcove 1 and 2: the simulation results presented at the review showed some discrepancy between the fast PBEAM muons and the full GNUMI results for alcove 1.

The idea of instrumenting the outside of the decay pipe was determined not to be cost effective.

6. (Reviewer: A. Marchionni) The requirement to detect overall muon flux changes at the 1% level is useless if the proton intensity monitors do not have comparable precision. Anyhow in the muon system this comes from free because we are

required to detect asymmetries at the few percent level. From the physics point of view, i.e. to monitor target integrity, how well do we really need to monitor the total muon flux? My feeling is that we need to do a little better than what the proton toroids have been specified for.

There is no project requirement to monitor muon flux changes at the 1% level. The monitoring group has promoted this as an (aggressive) physics goal.

7. (Reviewer: S. Wojcicki) I see that the neutron rate in DHM is an order of magnitude higher than charged particle rate and it appears to come from the absorber. I would suggest investigating moving the DHM few meters back (ie shortening decay pipe) and putting in neutron absorber (concrete?) with a reentrant hole for the beam in it. Just moving it back few meters might gain you some factor from the solid angle.

Given sufficient study and design, this may have been a reasonable change, however the existing hadron monitor configuration meets the project performance criteria.

Chamber Design
Presenter: D. Naples

1. (Reviewer: S. Wojcicki) If pressure and temperature variation is a serious concern on might want to consider outfitting small chambers in the common gas system that would be specifically designed to be sensitive to temperature and pressure variation.

If needed, a calibration chamber could be added at little cost at a later date.

Electronics & Bench Tests
Presenter: A. Erwin

1. (Reviewer: B. Bernstein) The plateau curve for the hadron system is not satisfactory. I was not clear as to whether the success of the muon group implies that a plateau exists for the hadron group since the fluxes are so different. I was unimpressed by the argument that Kopp made that a plateau was unimportant.

The plateau is unimportant for the system to meet the primary technical goal.

2. (Reviewer: J. Hylen) The dynamic range issue needs to be clarified. The current document shows (1) a factor of 40 eaten up by variation between pads, which may not leave enough room for variation in running conditions, and (2) pads which would fall below Albert's specification of 10 pC mininum for low intensity running. (I believe all is fixable, just not integrated yet).

OK

3. (Reviewer: J. Hylen) As discussed in the general comments, a propagation of specification of position accuracy to chamber response calibration should be incorporated in the hadron monitor specification document. I think this is needed before the calibration requirement can be understood for the hadron monitor.

OK

4. (Reviewer: A. Marchionni) Americium sources mounted on each PIC will provide good tracking with time of the response of the single pads. The question of the inter-calibration of the different PIC chambers is still an open one. From construction tolerances, variations of 2% and 10% were presented for 5 mm and 1 mm gap PICs, respectively. I think it would be nice to support these numbers with experimental data on the measured gains of a few different chambers. How does the 2% variation affect the possible measurement (by moving the target backwards) of alignment of the neutrino beam performed with the muon system? How does this measurement compare with the Near Detector one? How does this uncertainty affect the measurement of beam position with the downstream hadron monitors? I think that an inter-calibration of all the different pads is worth pursuing only if a cheap and easy solution is found.

These questions are not relevant to the ability of the monitoring system to meet the primary project goal.

Booster Beam Test
Presenter: R. Zwaska

1. (Reviewer: B. Bernstein) The radiation hardness of the hadron system is not adequately defined. The group could not come up with a consistent statement of either the level required or the level achieved. Numbers varied over an order of magnitude from roughly a factor of two to twenty better than required but the simulations have effects from delta-rays which are only roughly approximated. Deltas and soft fuzz are notoriously difficult to simulate and I doubt I would believe anything to a factor of two. I am told a test at a reactor facility is possible and I believe this should be aggressively pursued.

A test in the UT-Austin reactor was done.

2. (Reviewer: J. Hylen) In the tests done so far, the chamber center was in the beam but the readout wires were outside the beam spot. In actual operation, the readout wire routing will be in the beam, so it would be interesting to see what signal the beam might induce on that wire and whether mitigation would be needed.

Any effect is likely to be small and would not affect the ability of the monitor to achieve the primary goal (at low intensity).

3. (Reviewer: A. Marchionni) The tests on the 1 mm gap PICs performed at the Booster show that such detectors can cope with the downstream hadron monitors intensity. The main question here is the one of radiation resistance and in particular the understanding of the damage due to neutrons. So irradiation tests with low energy neutrons have high priority. Until this question is answered, we cannot decide if we keep detectors in all the time or just for commissioning/re-commissioning. In any case a mechanical design where the system is replaceable is highly preferable.

OK

4. (Reviewer: A. Marchionni) I found different numbers for the dose expected for the downstream hadron monitors: 2 10^11 rad/year in NuMI-B-0785 and 10^10 rad/year in the presentations. A radiation tolerance of 10^9 rad was presented, but that was probably a lower limit.

OK

5. (Reviewer: A. Marchionni) I was glad to see that even 1 mm gap PIC do not need H_2 to work reliably, but pure He is good enough. I think that H_2 should be avoided to minimize the signal due to neutrons, which would give large signals due to elastic scattering on free protons.

We are using He.

[Note: M. Messier and D. Michael are also listed as reviewers, but no comments are available on the web page.]