

## Comments on Review of Neutrino Device Instrumentation October 2001

### Introduction

Presenter: J. Hysten

1. (Reviewer: S. Childress) Due to the very intense radiation environment in the target / horn chase, besides design choices with rad hard components, it is prudent to both:
  - Develop alternative monitoring plans using instrumentation more remote from this environment which can be cross-calibrated in early running with the direct target region monitors

*The plans for the hadron and muon monitors already existed. We have now added two ionization chambers for the "cross hairs alignment system" that will very likely provide redundancy for the target Budal monitor. The cross-calibration of these will be done during commissioning.*

2. (Reviewer: A. Marchionni) How do we check that there is no water leak in the horn system ?

*During checkout, a leak check can be done by a modest overpressure of the system with air. During operation, a leak will be seen by the reduction of the level of water in the holding tank. Slow leaks will prompt visual inspection of the water lines to the modules. Leaks above the module will be fixed; we will continue running with slow leaks below the module. A large leak will require replacement of the horn.*

3. (Reviewer: P. Martin) It is proposed to monitor a fairly large number of parameters. This includes numerous voltage and current monitor points in the horn power supply, and thermocouples in many areas. While the overall concept appears fine, there was little presented on what to do with all this information. While some are important for protection of the horn and horn power supply, most are mainly of importance to the MINOS experiment. A block diagram should be generated, showing the overall architecture of the data acquisition system and how this data is shipped over to the MINOS experiment. Define which parameters need to be interlocked to the beam permit system, which to the horn power supply, and which need to be monitored (alarms and limits) in the Main Control Room. One route to getting the data to MINOS would be to collect all this information in ACNET, timestamping it, and then MINOS can read the data pulse-by-pulse. Verify that this will really suffice.

*The block diagram is being generated. All data for MINOS will follow the stated route, i.e. to ACNET, then ACNET to MINOS pulse by pulse. Beam permit devices are identified. The three systems for getting data into ACNET are identified (an MADC, an IRM, and a PLC). That the rate of MINOS reads from ACNET required is OK has not*

*been tested, but it is a much lower rate than that required by MiniBOONE, so we should be able to follow in their footsteps.*

4. (Reviewer: R. Pasquinelli) The work done on the horn power supply looks to be thorough. Many parts of the instrumentation that are being developed will also aid in the routine operation and troubleshooting of the system. This is just good basic engineering practice.
5. (Reviewer: R. Pasquinelli) For a technical review, very little technical engineering data was presented.

*It is my understanding that the NuMI/MINOS management desires to hold in general three reviews of each system. The early review aids in gathering input from stakeholders outside the project, for example in our case people in beams controls and operations, with whom the designs being developed must mesh. Such interface issues would be less of a problem if the NuMI project were more closely integrated into the Beams Division. The reviews also provide MINOS experimenters an opportunity to see that designs being developed meet their requirements - the addition of the cross hairs system is an example of such input. The resulting work should be more focused and productive because of the early review. Nevertheless, we understand that reviews consume resources and a balance needs to be struck.*

#### Horn Current Monitoring

Presenter: J. Biggs

1. (Reviewer: S. Childress) Consider adding a microphone system (positioned outside the shield) to give real time listening capability to the horn pulsing during operation. This can probably be very sensitive to mechanical system changes.

*This remains an interesting option, but we have not had the resources to address it. It would be an excellent item to add if some money remains at the end of the project.*

2. (Reviewer: A. Marchionni) It is important to check the stability over time of the electronics for the read out of the current transformers in the power supply, in order to preserve the stability and the precision of the current transformers themselves. A decision should be taken of whether to record the full pulse shape of the stripline currents. I believe that, besides the peak current, at least one additional point on the rising and one on the falling edge of the signals would be very useful for diagnosis of possible problems. The same requirements would apply to the signals from the Bdot coils. These are particularly promising for the monitoring of the magnetic field around the neck, and they can give indications of movements or warping of the inner conductor. The stability of the Bdot coil signal will be tested at the test stand in MI8. Nothing was said on how to check the timing of the current pulses. The general design of this horn monitoring system was done with both NuMI and MiniBoone in mind, but we learned that some of

the modules have to be adapted to the peculiarities of each one of these systems and especially calibrated. It is thus important to have readily available spares modules calibrated and adjusted for NuMI.

*Some stability testing has now been done at MI8, but not a recalibration of the DCCT coils, which would still be good to do. We have not yet seen enough potential benefit from recording pulse shapes to go to the added effort of building such a system. (Occasional fast-time-plots will be easy to take using the ACNET controls system, but the data would not be added to the MINOS data stream). A comparison of beam time obtained with the Budal and cross hair ionization chambers with the current pulse time of the horn will be read out every pulse, although the precise implementation of this is not developed yet.*

3. (Reviewer: F. Nezrick) Concerning the horn current maximum value-
  - a. we need a digital value of the maximum current at the  $\sim 1/4$  % level
  - b. we need the time of the maximum with respect to some clock pulse.

*See response above.*

4. (Reviewer: F. Nezrick) It would be useful to archive an indicator of the Horn current waveform. Possibly the times (relative to some clock pulse) of the 1/2 current points.

*See responses to other reviewers.*

#### Horn B-dot Coil and Target Budal Monitor

Presenter: J. Hylan

1. (Reviewer: S. Childress) A complement to the Budal target monitor should be the muon monitors, with an appropriate level of modeling done to understand their performance as a beam on target monitor if/when the Budal monitor fails.

*Both the muon monitors and the cross hair ionization chambers will be cross calibrated to the Budal monitor during commissioning. Since the cross hair system can detect the secondaries from beam hitting a 2% interaction length cross hair, detecting the signal from beam hitting a 200% interaction length target should be trivial. The signal expected in the cross hair chambers during normal beam operation is currently being Monte Carloed.*

2. (Reviewer: R. Ford) I am concerned about the Budal monitor. During the beam tests was proven that it works in principal, but I am concerned about the proximity of the device to the horn. I would suggest testing it in MI-8 inside the horn if this hasn't already been done. Also, it doesn't appear that the backup plan for using the muon monitors to monitor beam on target was well thought out. If

the Budal monitor fails 6 months into the run, are you comfortable with not having one?

*The noise levels around the horn have been looked at (although not with the Budal monitor) and the horn pulsing generates very little electrical noise. The horn pulse is very low frequency, and the horn being essentially a self-terminated coaxial cable is a very poor antenna. The Budal signal is large (nearly a volt during beam tests) and should be very robust against noise. In any case, the horn is not pulsed during the essential operation of the Budal monitor, which is a position scan of the beam across the target to check target alignment. The new cross hairs ionization chamber will allow target alignment checks in case the Budal fails.*

3. (Reviewer: F. Nezrick) Concerning the Budal monitor-
  - a. we should better understand it's lifetime (failure modes) with high radiation dose, review previous experiences.
  - b. what backup is reasonable if it fails - are the muon monitors a realistic backup.

*See reply to R. Ford.*

4. (Reviewer: F. Nezrick) What is the mechanical stability (straightness) of the LE target under pulsed beam operation with top and bottom cooling of the fins?

*We plan to test this next February when the production target arrives.*

Modules: Drive and Position Monitors, Thermocouples

Presenter: K. Anderson

1. (Reviewer: S. Childress) Prior to beam operation, it is very important to understand absolute positioning reference capability for baffle/target/horns by survey efforts above the shield.

*A test of the accuracy obtained by lowering a long graphite pole through shielding to tooling balls on the horns has been done in a mock-up, and the accuracy obtained appears adequate.*

2. (Reviewer: S. Childress) A design plan was indicated to have the capability to sweep the baffle completely to the side outside the beam. This transverse motion of several inches adds considerable design complexity, and it is not really clear that real benefit is provided. Suggest that commissioning alternatives be considered which do not require large motions of target chase components, except where this provides a significant clear benefit.

*The motion of the baffle is now locked to that of the target. We retain the capability to move the combined target/baffle carrier 8 inches to move it out of the beam to allow for the cross hairs alignment checks.*

3. (Reviewer: A. Marchionni) I think that the instrumentation presented for the horn support module is adequate, but since this is quite a complicate system, enough time should be devoted to test it, possibly rechecking the positioning after pulsing the horn and measuring vibrations. No details of the target support modules were given. Is there a way to prevent the target case from accidentally hitting horn1 ? And if that happens, would we know about ?

*An interlock is being developed to prevent the transverse positioning motors from being activated when the target is located anywhere that part of it extends into the horn. That is, transverse motors could only be operated with the target retracted. As the target is inserted, a simple ohm meter can tell if the target casing starts to touch the horn inner conductor. The motor controls will be locked out at all times except during special studies periods so that they are not accidentally activated. The system is still not fool-proof, as one could deliberately misalign the transverse motion and then drive the target into the horn while not watching for contact, but we feel the level of precautions taken above are reasonable.*

4. (Reviewer: R. Pasquinelli) Kris Anderson has presented much of the horn system in a previous review. Location of thermal couples was presented this time around. This is not a significant amount of additional information to warrant a review.

#### Closed Air Cooling Loop

Presenter: A. Stefanik

1. (Reviewer: F. Nezrick) Concerning the target pile air cooling system - I recommend an additional pressure drop indicator across only the prefilter. Since there is a big pressure drop across the HEPA filter it is sometimes difficult to know the condition of the prefilter if a single PDIT is used across both.

*This has been added.*

2. (Reviewer: R. Pasquinelli) Understanding procedures for dealing with a broken air flow system should be developed. This was present for review before the NuMI organization has figured out what to do in the event of a failure.

*The beam permit and hardware interlocks associated with the air cooling system have been documented for the intervening baffle review.*

## Thermocouple for Baffle

Presenter: J. Hylan

1. (Reviewer: R. Pasquinelli) The target baffle provides protection to the horn. It is being instrumented to monitor temperature. What is done with this instrumentation data is not clearly known at this time. Here again, a system was put up for review before much thought was given to the topic from within the NuMI group.
2. Procedures of how to handle effects of failure of the air cooling system or high temperature of the target baffle were not outlined or understood at the time of this review.

*The baffle temperature with respect to the beam permit system and normal operation is now well documented in the write-up for the intervening baffle review.*