Comments on a review of Primary Beam Instrumentation and Multiwire Conceptual Design
October 14, 2002

Responses by Bruce Baller
May 6, 2004

Update on NuMI Instrumentation
Presenter: S. Childress

1. (Reviewer: J. Crisp) OTR profile monitors should be seriously considered. It's a powerful statement that one of the chief consultants at CERN does not build multi-wire profile monitors any longer in preference to OTR's. Marc Ross at SLAC claims the foils can be made much thinner.

We have included an OTR in the baseline design.

2. (Reviewer: J. Crisp) The biggest problem we have with multi-wires is proper mounting and tensioning of the wires. The wires are built by winding the wire onto a frame by machine. The machine precisely controls the spacing as well as the tension. The frame is used to hold the wires while they are soldered into the grid. It is a delicate process that requires attention. The titanium foils are going to be more difficult and serious thought should be given to this procedure.

The UT-Austin design includes a comb for aligning the foils. It works well.

3. (Reviewer: R. Ford) The Beams Division (specifically the inst. and mechanical depts.) must maintain and operate these things after they are built and should be a willing participant in the design and operation of them. I am particularly concerned about the handling and baking procedures every time the devices are exposed to air. Miniboone has exposed its multiwires to air several times since installation and it would have been a pain to rebake them each time.

The Instrumentation Dept participated in all design discussions.

4. (Reviewer: V. Scarpine) In general, I feel that the design is very sensitive to the mechanical handling and long term stability of the foils. It may be a very difficult mechanical assembly.

It is not a difficult assembly.

5. (Reviewer: V. Scarpine) Also, it wasn't clear why OTR detectors are not being considered. A simple OTR system could be assembled quite cheaply.

We have included an OTR.

6. (Reviewer: B. Webber) I highly recommend contacting Mike Plum (scientist) mailto:plum@lanl.gov and/or Ross Meyer (mechanical engineer) at Los Alamos to get information on the wire scanner mechanical acutators they are developing with Huntington for the SNS project. I know they have done quite a lot of work and have looked at positioning repeatability, etc. There is assorted material on the Web at http://www.sns.gov/diagnostics/diaghome.html. The mechanical actuator can be expensive in terms of development time if you start fresh.

OK

Conceptual Design for NuMI Multi-Wire SEMs
Presenter: S. Kopp

7. (Reviewer: T. Anderson) If foil is used, what is it's sensitivity to shock. i.e.: mechanical shock as in installation and pressure shocks from pumpdown and letting the system up with N2. During let-up or a system failure there could be a significant pressure wave moving through the beam pipe.

We are studying these possible effects. Administrative controls on pump-down and let-up may be necessary.

8. (Reviewer: T. Anderson) What is the sensitivity of the foil to cleaning processes? The foil could be exposed to various chemicals and contaminants during fabrication and must be able to be cleaned and baked.

An acceptable cleaning process has been developed.

9. (Reviewer: T. Anderson) There was concern about the material used for guide clamps, this could be a stainless steel bearing assembly (dry no grease). Synthetic materials may not hold up under a bake and typically have high out-gassing rates.

Comment obviated by re-design of motion control.

10. (Reviewer: T. Anderson) Out-gassing tests should be done on the materials. To the first order this could be done by putting an equivalent amount (samples that have equivalent surface areas or volumes to the parts that will be used) of the non standard materials (those that are not stainless steel or that have potential trapped spaces) in a vessel of sufficient size that the samples would dominate the gas load. The out-gassing should be measured at steady state (not rate of rise) and an RGA analysis should be included.

Done.

11. (Reviewer: J. Crisp) It was not clear how the signal wires are connected to the strips. As Dan Shoo indicated, you may want to look at how multi-wire grids are connected.

Done.

12. (Reviewer: J. Crisp) The LVDT should work over the full range of motion. A second, high resolution LVDT could be added to work only near the in position.

Decided not to accept this suggestion. The cost and complication are not worth the benefit.

13. (Reviewer: J. Crisp) The tunnel environment can be very humid. Although environmental controls will attempt to keep the tunnel above the dew point, this system will fail eventually. These devices must be designed to handle that eventuality. An enclosure surrounding the device with a small heater could insure the delicate mechanisms and electrical connections remain dry.

The profile monitor is enclosed in a housing with the option of purging with dry gas.

14. (Reviewer: J. Crisp) Fiducials that are accessible from the outside after the device is installed are required. The accuracy of wire position with respect to these should be clearly understood. The survey group should be asked to comment on the design.

Done.

15. (Reviewer: J. Crisp) The 50% variation in titanium thickness is a concern for both mechanical strength and signal accuracy.

Beam tests indicate that this is not a problem.

16. (Reviewer: J. Crisp) Some information suggests a clearing field is required based on changes in profile with beam intensity. The magnitude of these changes was not known. Approximations were used to suggest a round hole in the clearing field plane for the beam to pass through would be ok. These ideas should be more concrete before they are designed into the system. The effect has not been seen at Fermilab, without clearing fields, in spite of a large dynamic range in beam intensities. The effect may simply be attributed to a reduced signal to noise ratio?

Beam tests indicate that a clearing field is necessary.

17. (Reviewer: J. Crisp) Linear motion slide bearings need to be made to withstand baking.

OK

18. (Reviewer: R. Ford) It does not appear that all the beam heating and tension issues are understood.

UT-Austin has modeled these effects and published a NuMI note.

19. (Reviewer: R. Ford) Having a backup plan to use wires if the foils become a problem would be useful.

Done.

20. (Reviewer: J. Krider) There is a related question of how much tension is needed on a 7 inch long strip to keep it straight enough under transverse stresses of gravity or asymmetric heating across the width. Also, what happens to the strips during baking or during pumping down or letting up the vacuum, when there is significant gas pressure on the strips?

See above responses.

21. (Reviewer: J. Krider) How are electrical connections made to the strips? I have seen spot welded joints on CERN strips, and the first generation Pbar target SEM had spot welded wires that worked well but required significant practice.

We are using conductive epoxy.

22. (Reviewer: D. Pushka) Concerns expressed about the connector and the humid environment may have a simple solution. The ceramaseal feed thru connected to a D connector and coat the D connector with a little di-electric grease. If it is necessary to be really over careful, put all of this into a gasketed electrical box and place a small bag of dessicant in the box with the connector before tightening down the cover.

See above response.

23. (Reviewer: V. Scarpine) What is the long term mechanical stability of the foils? Since the foils will be crimped, how uniform will the tension remain? What are the foils mechanical vibration response? Will repeated motion cause a change in foil position over time?

Long-term stability will be determined by experience in the NuMI beamline. The uniformity of the tension is not critical however the minimum tension is. Vibration of the profile monitor should not be an issue since the monitor is supported from the floor and coupled to the beam-pipe with a bellows. There should be no repeated motion/vibration or change in foil position.

24. (Reviewer: V. Scarpine) Since the foils will be used to calibrate the BPM's, what will be used to calibrate the foils after assembly in the beamline? What cross-check will be used to insure that the foils have maintained position from assembly until insertion into the beamline?

The alignment group is performing QA checks of the foil position to validate the UT-Austin measurement.

25. (Reviewer: D. Schoo) I suggest that the signal cable bundle be an "adhesiveless" Kapton ribbon. We have had excellent results with these on the multiwire detectors. They are radiation tolerant, vacuum compatible and provide a sturdy mounting for the signal wires especially since the end connections will need to have a good mechanical support and minimal pull stress for terminating to the foil ribbons. They can be made in almost any shape to match the physical dimensions of the interface and they flex easily for connection to things that move.

Done.

26. (Reviewer: D. Schoo) I might also suggest a hermetic vacuum feedthrough connector for the signals. Before we used the 50 pin D-sub connectors on the multiwire detectors, we used a 55 pin circular vacuum feedthrough connector with a small shell. We converted to the D-sub because it was far easier to mount and to terminate the flat-to-round cable into the mating connector. The mating D-sub is not hermetic which would not be advisable in the damp environment. We have samples of a Sealtron #MS27470Y17E35P and mating Aero #MS27467T17B35S that may be evaluated. The feedthrough connector is a solder cup type on the vacuum side but others are available with long pins that a flat cable can be easily soldered to. PC layouts already exist for this footprint.

Done.