Findings

The Mu2E Grounding and Shielding Policy is an excellent guide for the design of the detector.

The overall ground design has a separate building ground and 3 independent earth grounds for the detector systems.

The Extension Monitor, the Muon Stopping Target Monitor, the Trigger and Data Acquisition System and the Detector Controls and Monitoring system are either spatially separated or optically isolated so any noise or grounding issues are local to these systems. The grounding design for these systems appears to be adequate.

The Cosmic Ray Veto system is similarly isolated but has a modest voltage level (54 volts) that by OSHA rules would require all modules to be tied together to a common ground.

The Solenoid System follow standard accelerator division practice for large super conducting magnet systems. The Solenoids have redundant monitoring and quench protection systems and the design has provided sufficient mitigation for all apparent hazards.

The Calorimeter is a low noise, high bandwidth system. They presented a detailed conceptual design for the grounding and shielding but it did not address potential high frequency current paths.

The Straw Tube Tracker is the most challenging element of the experiment. It is a very high bandwidth detector and the presentation concentrated on the low frequency ground paths.

Comments

The maximum power supply current for the high voltage for the cosmic ray veto system is only a few microamps so it is not a safety hazard. Each module can and should be isolated which will provide better noise immunity and will be much easier to implement.

High frequency couplings between detector components are potential sources of ground loops and cross talk. Calculations and measurements are needed to verify that the ground design will work at the detector operating frequencies.

Dielectric breaks are often important to control noise from accelerator and mechanical systems. Little information was presented on this.

Careful attention needs to be paid to mechanical systems such as variable frequency drives and other mechanical devices. These devices can be sources of detector noise and are expensive to fix.

Isolating each plane in the straw tracker may be difficult due to the inter plane capacitance. Capacitance between the tracker and the solenoid may give rise to a low impedance connection between detector and building ground.

Recommendations

Racks for the trigger and DAQ system should follow telecommunications grounding practices where all racks are electrically bonded together and connected to building ground. This ground connection is independent of the power ground.

Provide corrosion free connections to all aluminum structures.

The grounding policy guide has many detailed recommendations. Extracting a concise list of requirements and recommendations will make it easier for designers to follow the guide.

Charge Questions

1. Does the overall plan for the grounding & shielding of the Mu2e experiment adequately address the likely or potential noise problems that the experiment might encounter? Is it likely that the grounding & shielding plan will allow the experiment to achieve the required noise performance for each subsystem?
    - The plan seems adequate at DC levels but at higher frequency problems may be identified that could need additional work.
    - Adding a set of good practice guidelines and a mechanism for identifying exceptions to those guidelines would likely improve the probability of achieving the required noise performance.
2. Is the technical design of the grounding & shielding technically sound? Have all the principal issues been addressed in the design? Aside from implementation details that remain to be worked out and documented, are there any outstanding concerns that need to be addressed?
    - The technical design of the grounding and shielding plan seems basically sound and most of the principal issues have been addressed at least at lower frequencies.
3. Are there any significant risks in the grounding & shielding design? Have mitigation plans been adequately developed
    - There seem to be no significant risks other than the high frequency behavior risks mentioned above. The presentations and plan did not cover possible mitigation strategies. Alternate schemes should be developed prior to construction so that possible alternate “ground’ points will be present if needed.
4. Has electrical safety been adequately addressed and included in the design? Are there any outstanding safety concerns or issues?
    - Safety has been well addressed throughout the presentations in terms of safety grounds and equipment grounding. Paying attention to insulation ratings for materials used in high voltage systems – especially mixed low and high voltage distribution systems is important.