Contribution ID: **3** Type: **Oral**

Single Event Upset Studies Using the ATLAS SCT

Thursday 26 September 2013 11:10 (25 minutes)

Single Event Upsets (SEU) are expected to occur during high luminosity running of the ATLAS SemiConductor Tracker (SCT). The SEU cross sections were measured in pion beams with momenta in the range 200 to 465 MeV/c and proton test beams at 24 GeV/c but the extrapolation to LHC conditions is non-trivial because of the range of particle types and momenta. The SEUs studied occur in the p-i-n photodiode and the registers in the ABCD chip. Comparisons between predicted SEU rates and those measured from ATLAS data are presented. The implications for ATLAS operation are discussed.

Summary

Single Event Upsets (SEU) are a cause for concern for the inner detectors at the High Luminosity LHC (HL-LHC). It is therefore important to understand the SEU rates observed in the current detector during LHC operation. In the ATLAS SCT, SEUs are expected to occur in the on-detector p-i-n photodiode which receives the optical Timing, Trigger and Control data. An error in the receipt of the trigger signal will cause a silicon detector-module to lose synchronisation with the rest of the detector. Therefore even low SEU rates can lead to significant loss of data. Registers in the front end ASIC for the SCT can be flipped by SEUs. While the loss of data in the pipeline or buffer will be negligible, the effects of SEUs on the static registers will have long lasting effects. For example, bit flips within the threshold register can increase or decrease the charge threshold required to register a hit. This may result in either loss of hit efficiency or high noise for data from that ASIC until the registers are reconfigured.

The SEU cross sections for the p-i-n photodiodes and the ABCD registers were measured in pion and proton test beams with a limited range of momentum and the results will be briefly reviewed. The SEU rates in the p-i-n diodes were determined by monitoring the rates of module desynchronisation. In principle these results can be used to predict the SEU rates during LHC operation, however there are many non-trivial corrections that need to be evaluated: the largest correction is due to the range of particle type and the spectrum at the LHC. A first approximate correction was estimated by scaling the SEU cross sections with measured hadron-proton cross sections. Ongoing studies will improve this by using hadron nucleus cross sections. The test beam data were all taken at fixed angles between the beam and the devices whereas the particles in LHC operation will cross the detectors at a range of angles. LHC data were used to study the effect and determine a correction factor. For the SEUs in the p-i-n diodes, correction factors were also estimated to allow for the bunched nature of the LHC operation compared to the DC test beams. The SEU rates in the p-i-n diodes are very sensitive to the p-i-n currents and this was also accounted for in comparisons between test beam and LHC operation. Overall reasonably good agreement between the predicted and measured SEU rates was found. This gives confidence in the ability to extrapolate test beam results to HL-LHC operation.
Finally the implications for ATLAS operation are discussed. The loss of module synchronisation is mitigated by the automatic reconfiguration of individual modules if errors are detected by online monitoring. The effect of ASICs becoming noisy due to SEUs is reduced by detecting this from the online monitoring and reconfiguring that module. In addition all modules are resynchronised every 30 minutes to ensure all registers are correctly set.

Authors: DAFINCA, Alexandru (University of Oxford (GB)); WEIDBERG, Anthony (University of Oxford

(GB)); ROBINSON, Dave (University of Cambridge (GB)); HENDERSON, James (University of Oxford (GB)); MCMAHON, Stephen (Rutherford Appleton Laboratory)

Presenter: WEIDBERG, Anthony (University of Oxford (GB))

Session Classification: Optoelectronics and Links