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The ATLAS Radiation Dose Measurement System and its Extension to SLHC Experiments

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In LHC experiments, a precise measurement of the radiation dose at various detector locations is crucial. In ATLAS, this task is performed by a set of radiation monitors (RADMON) which are able to record Non-Ionising Energy Loss (NIEL), the Total Ionizing Dose (TID) and measure fluences of thermal neutrons. These measurements are vital for understanding the changes in detector performance during ATLAS operation, verifying simulations and optimising the operation scenario. The RADMONs are multi-sensor boards, containing several RADFETs, diodes and DMILL transistors. It is clear that a similar system will be of even greater importance for SLHC environments due to the increased radiation dose.

Summary

In the ATLAS experiment, accumulated radiation doses are measured online at several locations in the detector. The measurement is provided by Radiation Monitor Sensor Boards (RMSB) that are realised as multi-sensor units. Different sensors are used to measure the Non-Ionising Energy Loss (NIEL), Total Ionizing Dose (TID) and fluence of thermal neutrons. The highest radiation levels will occur in the ATLAS Inner Detector (ID) around the pp-collision point.

In the ID, RMSBs will be placed at 14 locations and will provide on-line information of ionization dose in Si02, NIEL in silicon Radiation Field Effect Transistors (RADFETs) and damage to the DMILL bipolar transistors from which fluence of thermal neutrons can be estimated. Mainly due to the very uncertain temperature conditions at some locations in the ID, where the expected temperatures are between -20 and +20℃, the RMSBs were made of ceramics. They provide mechanical support and electrical connection for the sensors and the bottom side of the ceramics is covered with a thin layer of material with electrical resistance R = 320 Ohm which serves as the heater. The heater enables us to keep the board at a constant temperature a few degrees above 20℃.

Due to the large range of doses, very limited access, and relatively low number of RMSB locations due to limited space, RMSBs in the Inner Detector will host a number of radiation detectors which will cover the entire range of expected doses and provide a high level of redundancy. Outside the Inner detector the range of expected dose levels are smaller therefore TID and NIEL damage will be measured with simplified version of RMSBs containing only two sensors, one for each type of radiation damage (TID and NIEL). There are around 50 locations for RMSBs: 24 in the ATLAS calorimeters (6 in TILE and 18 in LAr), 10 for electronics at PP2, 16 in Muon forward detectors.

We will report on the status of the radiation monitoring project in ATLAS, and discuss a possible extension of the system to the radiation doses as expected for the experiments at the SLHC.

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