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A Silicon Strip Tracker for ATLAS after the HL-LHC Upgrade

While the Large Hadron Collider (LHC) at CERN continues to deliver increasing amounts of luminosity to the experiments, a phased upgrade of the LHC is planned, ultimately aimed at a luminosity of ten times the LHC design luminosity (HL-LHC). To cope with the expected harsh operating conditions in terms of particle rates and radiation dose, the ATLAS collaboration is developing a new tracker. In our presentation, we give an overview of the ATLAS tracker upgrade project, focusing on the silicon strip layers. We discuss technology choices for the sensors and present mechanical and electronic aspects of proposed module designs.

Summary

While the Large Hadron Collider (LHC) at CERN is continuing to deliver an ever-increasing luminosity to the experiments, a phased upgrade of the LHC is planned, ultimately aimed at increasing the integrated luminosity to about ten times the original LHC design luminosity (HL-LHC). To cope with the harsh conditions in terms of particle rates and radiation dose expected during HL-LHC operation, the ATLAS collaboration is developing technologies for a complete tracker replacement. This new detector will need to provide extreme radiation hardness and a high granularity, within the tight constraints imposed by the existing detectors and their services. An "all silicon"high granularity tracking detector is proposed.

Silicon sensors with sufficient radiation hardness are the subject of an international R&D programme, working on pixel and strip sensors. The efforts presented here concentrate on the strip layers. We have had fabricated a number of large area prototype planar detectors produced on p-type wafers to designs suitable for use at HL-LHC. These prototype detectors and miniature test detectors have been irradiated to a set of fluences matched to HL-LHC expectations. The irradiated sensors, along with several prototype modules using prototype HL-LHC readout electronics, have been studied in order to determine performance after doses of up to a few 1015 1-MeV neutron-equivalent per cm2.

In addition to producing full-scale (5120 channel in 40 ASICs per 9.75cm×9.75cm sensor) modules for the irradiation programme, several tens of prototype modules have been produced for multi-module assemblies. These have been designed to demonstrate the proposed next level of electrical and mechanical integration in the anticipated tracker structures, and have allowed testing of many critical aspects, including different powering options (serial power and DC-DC conversion).

In our presentation, we give an overview of the ATLAS tracker upgrade project, in particular focusing on the silicon strip layers. We discuss the challenging mechanical and electronic aspects of the proposed detector, which requires lightweight yet mechanically very rigid detector modules with a high level of service integration, producing high bandwidth data and with stringent cooling requirements. We present both mechanical and electronic test results relevant to the final anticipated performance in the upgraded detector.

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