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Double-sided silicon strip modules for the ATLAS tracker upgrade in the High-Luminosity LHC collider

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The Large Hadron Collider (LHC) will extend its current physics programme by increasing the peak luminosity by one order of magnitude. For ATLAS, an upgrade scenario will imply the complete replacement of its internal tracker. The super-module programme is an integration concept for the barrel short-strip region of the future ATLAS tracker in which double-sided silicon micro-strip modules are assembled into a local support structure. Results from first module prototypes will be reported. The electrical performance of several modules integrated together into a common structure will be shown.

Summary 500 words

The Large Hadron Collider (LHC) at CERN is currently providing proton-proton collisions with continous increase in the luminosity delivered to the experiments. ATLAS is a general purpose detector designed to fully exploit the physics potential of the LHC at a nominal luminosity of 1034 cm-2 s-1. It is planned to extend the LHC physics programme by increasing the instantaneous peak luminosity by one order of magnitude in the so-called High-Luminosity LHC (HL-LHC). For ATLAS, an upgrade scenario will imply the complete replacement of its internal tracker, since the current detector will not provide the required performance due to cumulated radiation damage and the huge increase in the channel occupancy. A new all-silicon based tracker is currently being designed. Several international R&D programmes are investigating all aspects required for a successful new tracker, from very radiation hard silicon sensors and front-end electronics to novel power distribution schemes.

The super-module concept will be presented as the integration solution for the barrel strip region of the future ATLAS tracker. The minimal detecting unit is a double-sided silicon micro-strip module. It consists of two n-on-p silicon micro-strip sensors glued to a central Thermo-Pyrolitical-Graphite (TPG) baseboard. The TPG provides mechanical stability and ensures excellent thermal contact for optimum heat dissipation. Two aluminum-nitride facing plates located at each far-end of the baseboard and four hybrids, two per module side, are bridged on top of the facings so that the hybrids are not only thermally decoupled from the silicon detectors but also any electro-mechanical damages to the sensors are being minimized. Each hybrid contains 20 readout ASICs. The heat generated from the front-end electronics is transfered to the cooling pipes located in the lateral sides of a light-weight carbon-carbon support structure in which the modules are mounted.

In our presentation, we will give an overview of the super-module programme. We will report on the design and fabrication of first double-sided module prototypes. The expected thermal performance from FEA simulations will be described. The electrical performance of the modules will be presented, emphasizing the main figures of merit (the noise at the discriminator input of the front-end and the noise-occupancy). The construction of a real-sized demonstrator of the local-support structure will be described. Electrical results of several modules integrated together into the larger structure will also be shown.

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