Contribution ID: **233**   Type: **POSTER**

Strip sensor performance in prototype modules built for ATLAS ITk

Saturday, 14 December 2019 14:35 (1 minute)

The ATLAS Phase-II Upgrade for the High-Luminosity LHC features replacement of the Inner Detector with an all-silicon Inner Tracker (ITk). The majority of the instrumented area in ITk is occupied by strip modules covering 165 mˆ2. A vigorous R&D program has been on-going for many years to prepare for the scale of the project and to work out technical issues at all key components of the system, including the strip sensors, readout ASICs, hybrids, modules, and staves.

In this submission we report on the performance of silicon strip sensors used in the last completed round of module prototyping. Over 80 modules were built and tested with electrical readout on the per-channel basis and the sensor performance was assessed. In general, an excellent performance was observed, consistent with previous ASIC-level and sensor-level tests. However, the lessons learned included two phenomena important for the future phases of the project. First was the need to store and test the modules in a dry environment due to humidity sensitivity of the sensors. The second was a rare observation of high noise on some channels, at the rate of about 3%.

The high noise regions were tested further in several ways, including monitoring the performance as a function of time and bias voltage. Additionally, direct sensor-level tests were performed on the affected channels. The inter-strip resistance and bias resistance tests showed low values, indicating a temporary loss of the inter-strip isolation. A subsequent recovery of the noise performance was observed. We present the test details, an analysis of how the inter-strip isolation affects the module noise, and relationship with sensor-level quality control tests.

Submission declaration

Original and unpublished

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Session Classification: POSTER

Track Classification: Strip sensors