

Evaluation of quality control (QC) of ATLAS18 production ITk strip sensors

ABSTRACT for HSTD14

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To address the demanding operational requirements of the High-Luminosity upgrade of the Large Hadron Collider (HL-LHC), the ATLAS experiment is replacing its current Inner Detector with a new all-silicon Inner Tracker (ITk). The ITk will feature an active sensor area of 165 m², with its outer tracking layers populated by approximately 20,000 ATLAS18 n⁺-in-p silicon strip sensors manufactured by Hamamatsu Photonics K.K. (HPK) and glued-on hybrids carrying the front-end electronics necessary for readout. The silicon sensors, available in eight shapes tailored for barrel and endcap modules, are designed to tolerate fluences of up to 1.6×10^{15} neq/cm² and ionizing doses of 66 MRad.

A comprehensive, multi-year Quality Control (QC) program is underway across multiple international institutes to evaluate these ITk strip sensors for mechanical and electrical conformity. The QC process includes IV/CV characterization, full strip tests, long-term current stability monitoring, visual inspection, and metrology tests. To manage the high throughput of about 500 sensors per month, the collaboration has implemented standardized test procedures, software packages, unified data formats, and automated analysis tools. The standardization ensures consistent pass/fail evaluation and centralized data handling that enables effective identification of trends and anomalies at all sites during multi-year production.

This contribution will present an overview of the ITk strip sensor production and QC framework, along with key findings through the whole production such as charge-up of sensors, stability of the leakage currents, nonrecoverable I-V breakdown, and low inter-strip isolation. It will provide insights into sensor yield, quality trends, and review specific case studies, such as p-stop doping non-uniformity. Over 86% of the production, totaling over 530 batches, are tested and accepted as-is. Six batches are rejected: two due to instability and non-recoverable I-V breakdown, and four due to non-uniform p-stop doping. Additionally, 1.8% of individual sensors are rejected after visual inspection, non-recoverable I-V breakdown, and other issues. In total, 2.9% sensors were rejected, including both individual sensor rejections and batch rejections.