Eleventh International Workshop on Semiconductor Pixel Detectors for Particles and Imaging

ID de Contribution: **33** Type: **Poster**

Towards the construction of the ATLAS ITk Pixel innermost layer

jeudi 21 novembre 2024 13:42 (3 minutes)

With the beginning of the High Luminosity program of the Large Hadron Collider (HL-LHC) the ATLAS detector will have to face an increased instantaneous luminosity up to $7.5\cdot 10^{34}$ cm^{-2} s^{-1} and an average of 200 proton-proton collisions per bunch-crossing. To be ready for these challenging beam conditions the ATLAS Inner Detector will be completely replaced with a new all-silicon Inner Tracker, the ITk, made of a Pixel detector at a small radius and a large area Strip detector surrounding it. The design phase of the ITk has been completed and the project is now moving into the production phase.
The new Pixel tracker is based on hybrid detectors, made of a readout chip implemented in the 65 nm technology and a silicon pixel sensor, the interconnection between the two parts is made via the bump-bonding technology. Two technologies have been chosen for the pixel sensors: planar sensors for the outermost layers and 3D pixel sensors for the innermost layer. The choice for 3D sensors is driven by their built-in radiation hardness since the innermost layer will reach a fluence up to $2\cdot 10^{16}$ n_{eq}/cm^2 (with a 1.5 safety factor) which is not suitable for planar sensor operation. To reduce the budget material of the detector the serial powering scheme will be implemented. Moreover, to cope with the increased luminosity, the system has been design to sustain high-speed data transmission at 1.28 Gb/s.
This talk aims to give an overview of the status of the ITk innermost layer. The ITk innermost layer, placed at 34 mm from the beamline, will play a crucial role in the tracker performance, driving the accuracy of the track impact parameters and, as such, the reconstruction of primary/secondary vertices, the identification of primary leptons, up to the performance of high-level objects like b-tagging and light-jet rejection. \par
The talk will focus on the performance of 3D pixel sensors, measured in several test beam campaigns, after irradiation up the ITk innermost layer end-of-life fluence (2e16 n_{eq}/cm^2, considering a 1.5 safety factor). Then it will present the results of the assembly procedure in the production sites, quality control and assurance of the pixel modules assembly and testing, mainly focusing on the quality of the bump-bonding connection, that has been validated through dedicated bumps delamination studies. Finally, the talk will cover the results of the data transmission tests carried out at 1.28 Gb/s with the Time Domain Reflectometer technique.

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Classification de Session: Posters

Classification de thématique: High energy and nuclear physics experiments