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Up-to-date test beam results of ATLAS ITk Pixel sensors and modules

The ATLAS Inner Detector will be entirely replaced with a new all-silicon tracking detector (ITk) in 2026–2028 to meet the demands of the High Luminosity LHC (HL-LHC). The innermost region of ITk will be instrumented with 3D sensor technology at Layer 0 (L0), where the expected fluence reaches up to 2×10^{16} neq/cm², while the outer layers (L1–L4) will feature n-in-p planar hybrid modules with sensor thicknesses of 100 μm and 150 μm.

Beam tests play a critical role in assessing the performance and operational characteristics of these sensors and modules, both before and after irradiation at HL-LHC-relevant fluences. Over the past few years, multiple sensor designs from different vendors have undergone systematic testing. The 2024 test beam campaign introduced novel sensor types produced using enhanced fabrication techniques, along with modules incorporating the latest version of the ITk readout chip. Thick planar sensors from Micron have been evaluated before and after irradiation as part of several test beam campaigns conducted throughout 2024.

Furthermore, the final iteration of the ITkPixV2 readout chip was submitted in March 2023, and the first modules assembled with this chip were successfully tested in summer 2024. The 2025 testing phase marks an important milestone, with the introduction of new triplet-configured 3D sensors and quad-configured planar sensors, now undergoing irradiation studies. This ongoing test beam program provides valuable insights into sensor performance under operational conditions, ensuring the readiness of ITk pixel detectors for HL-LHC physics.

This presentation will provide a comprehensive overview of ITk pixel sensor and module qualification efforts through test beams, incorporating the latest results from the 2024 and 2025 campaigns.

Workshop topics

Detector systems

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