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Analysis of humidity sensitivity of silicon strip sensors for ATLAS upgrade tracker, pre- and post-irradiation

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The ATLAS collaboration is working on a major upgrade of the Inner-Tracker, able to withstand the extreme operational conditions expected for the forthcoming High-Luminosity Large Hadron Collider (HL-LHC) upgrade. During the prototyping phase of the new large area silicon strip sensors, the community observed a degradation of the breakdown voltage (down to 200-500 V from $\geq$1 kV in bias voltage) when the devices with final technology options were exposed to high humidity, recovering the electrical performance prior to the exposure after a short period in dry conditions [J. Fernandez-Tejero, et al., NIM A 978 (2020) 164406]. These findings helped to understand the humidity sensitivity of the new sensors, defining the optimal working conditions and handling recommendations during production testing.

In 2020, the ATLAS strip sensor community started the pre-production phase, receiving the first sensors fabricated by Hamamatsu Photonics K.K. using the final layout design. The work presented here is focused on the analysis of the humidity sensitivity of production-like sensors with different surface properties, providing new results on their influence on the humidity sensitivity observed during the prototyping phase.

Additionally, the new production strip sensors were exposed to short (days) and long (months) term exposures to high humidity. This study allows to recreate and evaluate the influence of the detector integration environment expected during the Long Shutdown 3 (LS3) in 2025, where the sensors will be exposed to ambient humidity for prolonged times. A subset of the production-like sensors were irradiated up to fluences expected at the end of the HL-LHC lifetime, allowing the study of the evolution of the humidity sensitivity and influence of the passivation layers on sensors exposed to extreme radiation conditions.

Collaboration

ATLAS

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