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ITS3 in ALICE: pioneering bendable wafer-scale sensors for LHC Run 4

The ALICE experiment at the Large Hadron Collider (LHC) is preparing for an upgrade during Long Shutdown 3 (LS3, 2026-2030), which includes replacing the three innermost layers of the Inner Tracking System (ITS2). The new ITS3 detector will introduce an innovative design featuring wafer-scale monolithic pixel sensors in 65 nm CMOS technology, thinned to 50 μm and bent into truly cylindrical layers. This breakthrough allows for an ultra-light detector with a material budget of only 0.07% X_0 per layer and a reduced radial distance to the interaction point (19 mm), significantly enhancing tracking performance by a factor of 2, especially for low-momentum particles.

The ITS3 sensors are fabricated using a stitching technique to produce 27 cm-long monolithic detectors without the need for flexible printed circuits placed on top of the sensors. Extensive R&D efforts have demonstrated the feasibility of these sensors, confirming high resolution ($\sim$5 μm), high efficiency (>99%), low fake hit rate (<10^6 /pixel/event), and excellent radiation tolerance (up to 10^{15} 1 MeV n_{eq} cm^{-2}). Additionally, mechanical prototypes have validated the stability of bent sensors under operational conditions, including realistic air cooling and interconnection scheme.

This contribution will present an overview of the ALICE ITS3 upgrade project, together with the latest advancements in its development, covering sensor design and characterization, mechanical integration, and the progress toward the final MOSAIX prototype. Results from laboratory and beam tests will be discussed, highlighting the potential of ITS3 to redefine silicon tracking technology for future collider experiments.

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