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Testing small scale devices for ALICE ITS3 upgrade

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During the Long Shutdown 2 (LS2), the ALICE Inner Tracking System was upgraded to its second version ITS2, consisting of 7 layers of silicon CMOS Monolithic Active Pixel Sensors, the ALICE Pixel Detectors (ALPIDE MAPS). Thanks to the integrated read-out circuitry, ALPIDE MAPS thickness in terms of radiation length X_0 has already been reduced to 0.36%X_0 per layer in ITS2, but this could be further reduced to an average of 0.09%X_0 per layer by removing the non-silicon contribution to detectors'material budget.
This is the goal of the ALICE ITS upgrade to ITS3, to be carried out during the upcoming Long Shutdown 3 (scheduled for 2026-2028). After the upgrade the 3 innermost ITS2 layers (Inner Barrel, or IB) will be replaced by 3 flexible, truly cylindrical layers of stitched MAPS chips. The reduced need for supporting frames, as well as the substitution of the present water cooling system with air cooling, is expected to lead to a dramatic drop in material budget. Higher tracking precision and approximately twice a better pointing resolution than ITS2 (especially at low momenta) are also expected. Such improvements will greatly benefit physics studies on heavy-flavored particles with few tens μm long mean paths cτ.
The ITS3 sensors are produced using a 65 nm process, instead of the current 180 nm used in ITS2. A wide range of Multi-Layer Reticle 1 (MLR1) small test devices have been developed to validate this new technology, including Analog and Digital Pixel Test Structures (APTS and DPTS), designed to optimize pixel charge collection process and front-end configuration, respectively.
In this contribution results of MLR1 device tests will be shown. Measurements have been performed both under charged particle beams and in laboratory with a ^{55}Fe source, in order to investigate the MLR1 65 nm small test device performances and to compare them with the upcoming ITS3 goals (99% detection efficiency and 5 μm spatial resolution under up to 10 kGy TID + 10^{13} 1 MeV n_{eq}/cm^2 NIEL). APTS laboratory measurements have shown high charge collection efficiency after a low-dose n-type blanket implantation, while test beam results both on APTS and DPTS have proven that the expectations for ITS3 sensor detection efficiency and spatial resolution are met.

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