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Passive CMOS sensors for radiation-tolerant hybrid pixel-detectors

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The hybrid pixel detectors of the ATLAS and CMS experiments will be replaced for the operation at the HL-LHC in 2026. To maintain the tracking performance, the surface area of the future detectors will significantly increase while the pixel pitch decreases.

An attractive option for the production of the pixel sensors in such large area detectors is the utilization of a CMOS processing line. In addition to the cost-effectiveness and high-throughput of commercial CMOS lines, process features can be exploited to further enhance sensor performance. For example, field-plates can replace the common p-stop/p-spray inter-pixel isolation, poly-silicon layers enable biasing structures without a punch-through implementation, and MIM-capacitors allow for AC coupling.

After 5 years of R&D with passive sensors using the LFoundry 150 nm CMOS process, with many prototypes and design iterations, a milestone has been reached. In a dedicated submission full-size sensors have been produced that are compatible with the current RD53 readout chips and match the requirements of the ATLAS and CMS experiments.

This presentation will focus on the full-size sensor submission and depict latest results from irradiated prototypes (up to 1e16 neq/cm^2) and inter-pixel isolation structures with field plates. Sensor parameters such as detection efficiency, break down behavior, inter-pixel resistivity, and charge collection properties will be discussed.

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