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[D02] Design and performance of the Monopix2 reticle-scale DMAPS with a column-drain read-out architecture

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The development of depleted monolithic active pixel sensors ("DMAPS") aims to meet the hit-rate and radiation-hardness requirements of tracker systems in modern and future particle collider experiments. These devices use multi-well commercial CMOS processes to integrate sensor, front-end and read-out electronics in a single piece of silicon. Their radiation tolerance is enhanced through design efforts and the use of large enough voltages in highly resistive substrates to collect charge mainly by drift.

"LF-Monopix2" and "TJ-Monopix2" are the second generation of "Monopix" DMAPS prototypes fabricated in 150 nm and 180 nm CMOS processes, respectively. Both devices implement a fully functional column-drain read-out architecture at a reticle-size scale, but differ on the concept used for pixel design. LF-Monopix2 has each pixel's full front-end and read-out circuitry placed and isolated inside a charge collection node of a size comparable to the pixel area. On the other hand, TJ-Monopix2 separates all electronics from its small electrode within the pixel and uses process modifications to enhance its charge collection capabilities. The chips inherited and improved radiation-hard designs tested in their direct predecessors, while also reducing their pixel sizes and increasing their active column lengths to 1.7 centimeters.

The design and latest test results of unirradiated Monopix2 chips are presented. Their front-end performance was quantified according to their response to injected test pulses or radioactive sources. Moreover, a high and uniform in-time detection efficiency was measured on a test beam campaign for a successfully thinned-down and fully depleted LF-Monopix2.

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