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X-ray Irradiation Campaigns of the Monopix depleted monolithic active pixel sensors

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Monolithic active pixel sensors with depleted substrates present a promising option for pixel detectors in high-radiation environments. Leveraging high-resistivity silicon substrates and high bias voltages in commercial CMOS technologies facilitates depletion of the charge sensitive volume. This enhances the radiation tolerance and charge collection capabilities to meet the demands of such environments. TJ-Monopix2 and LF-Monopix2 are the most recent large-scale chips in their respective development line, originally designed for the ATLAS Inner Tracker outer layer environment.
LF-Monopix2 is designed in 150 nm LFoundry CMOS technology and integrates all in-pixel electronics within a large charge collection electrode relative to the pixel pitch of 50x150 µm2. This approach facilitates short drift distances and a homogeneous electric field across the sensor. The resulting sensor capacitance of approximately 250 fF compromises the noise performance requiring more analog power for optimal operation. The pixel layout has been optimized to minimize potential cross-talk from digital circuitry to the sensor node. LF-Monopix2 wafers have successfully been thinned-down to 100 um and backside processed.
TJ-Monopix2 is designed in 180 nm TowerJazz CMOS technology and features a small charge collection electrode, which requires the separation of the in-pixel electronics into p-wells. Process modifications in form of an additional n-type implant minimize regions with low electric field and improve the charge collection efficiency impaired by the long drift distances. The small pixel size of 33x33 µm2 reduces the detector capacitance to approximately 3 fF enhancing noise and power performance.
This contribution focuses on the performance of both Monopix2 chips after X-ray irradiation. Latest laboratory and beam test measurements are presented.

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