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Edgeless planar semiconductor sensors for a Medipix3-based digital radiography detector

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Due to its advanced pixel circuitry, the Medipix3 chip is an interesting read-out alternative to today's CCD- and TFT-based digital radiography detectors. Hybridised to a mono-crystalline high-Z semiconductor sensor, it can provide electronic-noise free and fine-grained colour X-ray images of high contrast. Nevertheless, the limited active area of the Medipix3 chip as well as single-crystal sensor wafers currently prevents replacement of large-area X-ray imaging systems. A seamless tessellation of multiple detector modules with edgeless sensors could solve this. We therefore study phenomena affecting the charge collection at the edge of slim-edge and active-edge planar sensors.

Two 150 μm thick active-edge n-in-n planar silicon sensors, hybridised to Timepix read-out chips, were mounted side-by-side and placed longitudinally in the CERN-SPS H6 beamline. Consequently, 120 GeV/c muons and pions traversed both sensors practically parallel to chip's plane and left behind long trails for accurate track reconstruction. The response of the edge pixels to particles traversing the detector under a small inclination and azimuthal angle was studied with two main objectives in mind: (i) to determine the minimum distance from the physical edge at which charge is collected; (ii) to map the electric-field distribution at the edge by relating the Time-over-Threshold information to the reconstructed interaction depth.

Additionally, we investigate the potential of reducing the electric field distortion at the edge by seamlessly mounting multiple pieces of slim-edge cadmium telluride on one Medipix chip. Supported by TCAD simulations, the flood-field uniformity of the adjacent edges is compared with that of the perimeter.

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