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Development of a backside biased HV-CMOS sensor in a 150 nm process node for particle detection

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High Voltage-CMOS (HV-CMOS) sensors are an attractive option for tracking applications due to their high-performance and cost-efectiveness. However, to meet the challenging specifications required by future physics experiments in terms of radiation tolerance, time resolution and granularity, further R&D is needed to boost the performance of these sensors. UKRI-MPW0 is a new HV-CMOS sensor prototype, developed in the 150 nm process technology from LFoundry, aimed at addressing some of these specifications.

This contribution presents the main design aspects and preliminary laboratory evaluation results of UKRI-MPW0. The prototype implements a novel sensor cross-section optimised for backside biasing at unprecedented high voltages and targeting a large improvement in radiation tolerance. The chip uses a 1.9 kΩ·cm high resistivity substrate, and samples have been thinned to 280 µm and backside processed following two different techniques, namely plasma immersion ion implantation with laser annealing and beamline implantation with rapid thermal annealing. The chip has two large active matrices, several test structures consisting of small passive matrices with different pixel sizes (from 40 µm x 40 µm to 70 µm x 70 µm) to characterise the sensor depletion region, and of linear and circular transistors to study their radiation tolerance. One of the active matrices uses linear transistors only, whereas the other active matrix uses circular transistors. Each matrix has 20 rows and 29 columns of pixels. The pixels are 60 µm x 60 µm and integrate analogue readout electronics inside the collecting electrode. Each matrix has three different pixel flavours, which are continuous reset, switched reset and modulated feedback, to study and improve the sensor time resolution. The chip has a total area of 5 mm x 3.5 mm.

Preliminary measurements before and after neutron irradiation have shown the chip is able to sustain high bias voltages much beyond other state-of-the-art HV-CMOS detectors. We are in the process of measuring the active matrices with the Caribou readout system. The measurements shown at the workshop will focus on diode and transistor I-Vs, and active matrix characterisation.

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