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Measurements and TCAD simulations of innovative DC-RSD LGAD devices for future 4D tracking

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Future HEP experiments will consider measuring concurrently the position and the time of a particle hit with very good accuracy, i.e., 4D-trackers will be the basic option for future detection systems. Within this framework DC-coupled Resistive Silicon Detectors (DC-RSD) low-gain avalanche diodes (LGAD), an evolution of the AC-coupled design, are considered a very promising option. They combine two different design innovations, LGAD and resistive readout (RSD), to achieve a spatial resolution of a few micrometres using large pixels (150-200 micrometres), providing an excellent time resolution (˜20-30 ps). The concept of DC-RSD has been finalized using an innovative mixed-mode approach to simulation: SPICE-based fast modelling to demonstrate the operating principle, followed by full 3D TCAD simulations to optimize the sensor design parameters. TCAD simulations are an excellent tool for designing this innovative class of detectors, enabling the evaluation of different technology options (e.g., the resistivity of the n+ layer, contact materials) and geometrical layouts (shape and distance of the read-out pads). In particular, a full 3D simulation domain guarantees a very accurate evaluation of the electrical behavior while providing very precise timing information, gaining access to the response of the detector device in terms of conduction and displacement currents.
This contribution reports the latest outcome of simulations, which have been instrumental in defining the design technical implementation. This contribution also describes the characteristics of the first DC-RSD production at FBK, to be submitted this summer, to explore multiple technological options and electrode layouts. Interesting information on the expected DC-RSD performance will be presented, extracted from recent experimental results obtained on AC- coupled resistive read-out sensors and on DC-RSD test structures.

Submission declaration

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