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Design and TCAD simulation of double-sided pixelated low gain amplification detectors

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A double-sided variant of low gain amplification detector is introduced, suitable for pixel arrays without dead-area in between the different read-out elements. Design options and selected results from TCAD simulations are discussed, along with the proposed fabrication process.

Summary

Low Gain Amplification Detectors (LGAD) are attracting wide interest within the HEP community. The first prototypes developed by CNM Barcelona have been characterized by several groups, showing very promising performance. These devices are potentially able to provide very good position and timing resolution at the same time, a fact that could open new opportunities in particle tracking detectors as well as in other application fields. Some studies have highlighted a severe gain reduction in LGADs after irradiation, so radiation tolerance should be thoroughly addressed in new device developments. In addition, alternative design and fabrication approaches are necessary to pass from pad detectors to strips and pixels. In fact, existing LGADs are built with a single-sided fabrication process, and feature a blank ohmic contact on the back side and read-out junctions on the front side, embedding an additional doping layer to control the avalanche multiplication mechanism and properly designed terminations to prevent from early breakdown at the edge. This works well for pads, but in case of patterned detectors it would lead to large spatial non uniformities in the signal amplitudes since charge carriers collected at the junction edges would experience no multiplication.
In this work, we propose a modified, double-sided LGAD structure, having a large multiplication region (n/p junction) on the back side and ohmic read-out pixels on the front side. The device concept has been validated with the aid of TCAD simulations, showing multiplication gains from a few units up to about 30 depending on the dose of the multiplication layer and on the operational conditions. The design options and selected simulation results will be presented, along with the proposed fabrication process to be implemented at FBK.

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