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Monolithic AC-LGADs, a new frontier in high-performance particle tracking in 4 dimensions

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In this contribution we present an innovative sensor concept suitable for 4D particle tracking, which is the result of combining two well-known technology solutions: the standard CMOS platform, on one side, and the AC-LGAD readout design, on the other. Being an evolution of the LGAD concept, AC-LGADs get rid of the no-gain area introduced by the isolation implants around each pixel thanks to the so-called RSD (Resistive AC-Coupled Silicon Detectors) paradigm, which consists in the use of a dielectric layer, that induces a capacitive coupling into the readout pads, and a n^+-type implant, acting as a resistive discharge path for multiplied charges.

While the monolithic approach ensures the most compact and effective coupling between the sensor and the front-end electronics, the AC-LGAD concept represents one of the most promising solutions to achieve high levels of space and time resolution, thanks to the internal gain and the particular readout design allowing the 100% fill factor. This combination could be the enabling technology for new generations of high-precision trackers designed to operate in high-luminosity environments, where the low power, low material budget and high efficiency requirements are essential.

Based on our consolidated experience in developing Monolithic Active Pixel Sensors (MAPS), we designed a numerical simulation framework to investigate the compatibility between the AC-LGAD concept and the 110-nm CMOS technology node. Our analyses show that these two aspects can be merged in a unique device, and that monolithic AC-LGAD sensors can be developed upon a standard process, based only on common fabrication parameters. Besides the device proof-of-concept, we will also present a numerical characterization of the dynamic performances of such innovative detector in terms of space and time resolution, through combined TCAD and Montecarlo studies.

Collaboration

Role of Submitter

I am the presenter

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