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Simulations and Performance Studies of a MAPS in 65 nm CMOS Imaging Technology

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Monolithic active pixel sensors (MAPS) produced in a 65 nm CMOS imaging technology are being investigated for applications in particle physics. Their main characteristic is integrating a sensing volume and readout circuit in the same silicon wafer, reducing material budget with respect to most hybrid sensors. Compared to the previously investigated 180 nm CMOS imaging technology, the 65 nm technology significantly improves the logic density of the circuitry. The investigated sensor design has a small collection electrode characterized by a low input capacitance, granting a high signal-to-noise ratio and low power consumption. These features are the main motivation for the Tangerine project, which aims to develop the next generation of silicon pixel sensors with a temporal and spatial resolution compatible with the requirements for a vertex detector at future lepton colliders. The developments are pursued in collaboration with the CERN EP R&D program on technologies for future experiments and with the ALICE ITS3 upgrade.

The project comprises all aspects of sensor development, from electronics engineering and sensor design using simulations, to laboratory and test-beam investigations of prototypes developed within Tangerine and the collaborating projects. The use of simulations when developing a MAPS is of great relevance, given the complex electric field configuration and the simultaneous need for high statistics. TCAD device simulations using generic doping profiles and Monte Carlo simulations have been used to build an understanding of the technology and predict the performance parameters of the sensor. Prototypes of a 65 nm CMOS sensor with a small collection electrode have been characterized in laboratory and test-beam facilities by studying their charge collection, spatial resolution, and efficiency. This contribution compares simulation results to test-beam data. The experimental results validate the employed simulation approach and establish this technology as a promising candidate for a vertex detector at future lepton colliders.

Submission declaration

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