Contribution ID: **211** Type: **Poster**

Simulating Monolithic Silicon Sensors in a 65 nm CMOS Imaging Technology

Tuesday 18 February 2025 16:10 (20 minutes)

Monolithic Active Pixel Sensors (MAPS) developed in a 65 nm CMOS imaging process offer a cost-effective alternative to hybrid pixel sensors by eliminating flip-chip bonding and enabling a reduced material budget through thinner active sensor layers. The TANGERINE project aims to develop a 65 nm MAPS sensor, with small collection electrode, optimized for future lepton colliders and beam telescopes. This project covers all aspects of sensor R\&D, from electronics and sensor design using simulations, to prototype test chip characterization in labs and at test beams.

Predicting the behavior of these silicon sensors is challenging due to the complex interplay between the doping regions, which leads to non-linear electric fields. Therefore, precise simulations are important for predicting sensor performance and guiding design improvements. The strategy for the simulations involves combining the Monte Carlo method with electric field simulations using Technology Computer-Aided Design (TCAD) with generic doping profiles.

The simulation results are presented alongside a detailed workflow. Key performance metrics, such as detection efficiency, cluster size, and spatial resolution, are analyzed to evaluate different pixel layouts, including a comparison between square and hexagonal geometries. Additionally, transient simulations modeling the time-dependent response of detectors to incident particles are also presented.

Primary experiment

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Session Classification: Coffee & Posters A

Track Classification: Semiconductor Detectors