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TCAD Simulations on Monolithic Pixel Sensors: Improving Timing Performance for ALICE at LHC

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During Long Shutdown 4 of the Large Hadron Collider (LHC), ALICE will be replaced by a completely new detector. It will offer unique insights into thermal dielectron production and heavy flavor probes in the quark-gluon plasma. This upgrade involves positioning the inner detector layer 5 mm from the interaction point, minimising scatterings, and enabling large-area curved sensors with the lowest material budget. These requirements are attainable thanks to recent breakthroughs in semiconductor technology and will employ the latest innovations in Monolithic Pixel Sensors (MAPS).

My research is predominantly focused on the advancement of Monolithic Pixel Sensors (MAPS), with a specific emphasis on augmenting their capacity for fast-timing measurements, aiming to attain a 20 ps time resolution and minimize power consumption to align with the objectives of the ALICE project. The performance of these sensors is contingent on numerous parameters, including pixel geometry, pitch size, reverse bias voltage, doping concentrations, and layer thickness. The variation and combination of these parameters are crucial to meet the final specifications.
Leveraging Technology Computer-Aided Design (TCAD) simulations, it becomes feasible to precisely model the electric field within each pixel, thus enabling the calculation of charge trajectories and transit times to the collection electrode. This powerful tool helps to determine the capacitance and power consumption for each proposed configuration, aiding in the selection of the most suitable design. Furthermore, the results obtained will guide the choice of the most radiation-resistant geometry, based on simulations of radiation damage in the sensor. This presentation will showcase recent findings regarding the timing capabilities of MAPS with various geometries.

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