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Simulation of signal creation in MAPS to speed up the characterization and development of sensors

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Monolithic Active Pixel Sensors (MAPS) are used in many high energy physics experiments, also in ALICE at CERN. To find the most suitable geometry for the current ALICE inner tracking system (ITS2), several slight modifications had to be processed and lots of manual characterisation was done. This added high costs and time to the project. Using modern TCAD device simulation software combined with the signal calculation capabilities of CERN's Garfield++ software one can simulate the sensor's signal creation down to the electron/hole pair level. Electric and weighting fields for the slight geometry modifications only have to be extracted once from TCAD. Signal generation is then done in Garfield++ by deposit of photons or MIPS and tracking the electron/hole pair movement through the sensor. The signal of single hit events can be extracted, stored and reused as input for electrical simulation software (SPICE, CADENCE) to design the read out electronics. The results are promising, seed pixel signal and cluster multiplicity of ITS2 radiation measurements could be recreated and timing capabilities for new geometries in view of upgrades during long shut-down 3 and 4 are investigated. With the recent development the signal behaviour of radiation detectors after different radiation levels to track degradation effects like trapping can be simulated as well. This paves the way for a full beginning to end simulation of MAPS detectors with all effects included.

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