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Allpix Squared Simulations of ATLAS ITk Strip Detectors

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Starting in 2022, the LHC will be upgraded to the High Luminosity-LHC, which will have a luminosity almost five times larger than the current luminosity. In order to cope with the higher radiation level and with the higher pile-up, the ATLAS experiment needs a complete replacement of the current tracking system with an all silicon detector, the Inner Tracker (ITk).
The ITk Strip Detector will consist of four barrel layers and six end-cap disks on each side. These building structures are populated with staves and petals, for barrel and end cap respectively. These local supports provide geometric stability, cooling performance and supply of electrical connections to and from the 2 modules. A module represents the basic detection unit of the detector. It consists of a ~ 10 x 10 cm n-in-p silicon microstrip sensor fabricated in a float-zone (FZ) substrate, with its associated power, control and readout electronics directly glued on top of it.
The detector simulation has always gone in parallel with the development of silicon detectors. It allows to improve the understanding of the detector performance and design optimization. Allpix Squared has a crucial role in this and its main use has been as a benchmark for test beam results.
Several simulations have been performed to evaluate the behavior of un-irradiated models. In order to do it, Synopsis Centaurus TCAD models of the electric field have been integrated in the framework. These Allpix Squared simulations have been compared with test beam data, giving useful insight on the behavior of the modules. The simulated hits have also been processed with the EUTelescope framework to perform the same analysis chain as test beam data. The comparison between both data sets is discussed. Moreover, the end-cap sensors implement radial strips (i.e. pointing to the beam-axis) in order to give a measurement of the rφ coordinate. As a result, these sensors have a wedge shape with curved edges.

Some changes to the framework were needed to process hits using a radial coordinate system as the measurement frame is orientated differently to local frame. Such modifications are discussed and preliminary results obtained in this way are presented. Finally, simulations of irradiated modules are crucial for a full understanding of their performance
and for future digitization models. The plan for simulating irradiated devices for the ITk Strip are discussed in this presentation, as well as some preliminary results.

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