1st Allpix Squared User Workshop

Report of Contributions

https://indico.cern.ch/e/apsq

Contribution ID: **1** Type: **not specified**

Introduction to the Allpix Squared Simulation Framework

Monday 26 November 2018 13:00 (30 minutes)

Presenter: HYNDS, Daniel (Nikhef National institute for subatomic physics (NL))

Contribution ID: **2** Type: **not specified**

CVMFS/Docker/Local: Installing Allpix Squared

Monday 26 November 2018 13:30 (30 minutes)

Presenter: SPANNAGEL, Simon (CERN)

Contribution ID: **3** Type: **not specified**

Importing and Using TCAD Electric Fields in Allpix Squared

Tuesday 27 November 2018 11:25 (30 minutes)

Presenter: MUNKER, Magdalena (CERN)

Session Classification: Advanced Features

Contribution ID: **4** Type: **not specified**

Charge Transport Methods

Tuesday 27 November 2018 10:45 (40 minutes)

Charge transport simulation is at the heart of reproducing the response of pixel detectors. In the Allpix Squared framework charge transport is also considered as the primary component where the framework has been constructed around. This contribution aims to give an overview of the current capabilities for charge transport in Allpix Squared. The main goal is to show the different charge transport methods the frameworks offers, their configuration options and how to integrate those in various simulation flows. Furthermore, several visualization techniques are demonstrated that are helpful in gaining an understanding of the simulation. Finally, some parts of the design and implementation are discussed in more detail, to show the flexibility the framework offers for adaption to various applications.

Charge transport in a Monte-Carlo setting requires a balance between sufficient precision of the results and a reasonable computing time for a single event. For this purpose the framework provides two different propagation methods at the module level. First a projection propagation module, producing fast results under the constraints of a linear electric field and at the cost of precision, and a much more powerful and wider applicable generic propagation module that uses a fourth-order Runge-Kutta method to perform a drift-diffusion simulation with support for user-provided electric and magnetic fields. The generic propagation module has been highly optimized for fast simulations, without losing sight of usability and flexibility for both users and developers.

To support different simulation scenarios the framework allows using multiple propagation methods at the same time for different detectors in the setup. Some dummy configurations are discussed to display the power of this approach. And even if the current capabilities are not sufficient, the framework allows to easily add modifications as shown in a simple example.

Presenter: WOLTERS, Koen (Eindhoven Technical University (NL))

Session Classification: Advanced Features

Contribution ID: **5** Type: **not specified**

Magnetic Fields and Lorentz Drift

Tuesday 27 November 2018 11:55 (20 minutes)

Presenter: SCHÜTZE, Paul (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Advanced Features

Contribution ID: **6** Type: **not specified**

New materials and high-Z absorbers for x-ray detection

Tuesday 27 November 2018 14:00 (25 minutes)

The flexibility of Allpix-squared allows for the inclusion of new absorber materials and detector geometries with relative ease. We will discuss an ongoing effort to include sensors with high-Z materials commonly used in medical and industrial digital x-ray radiography.
We have implemented charge carrier mobility parameterizations for materials and compounds such as Ge, SiGe, and GaAs. The specific case of a "monolithic x-ray sensor" where the absorber is covalently bonded to the silicon chip will also be shown.
The simulated geometry profits from the full functionalities of Allpix-squared (input of TCAD field simulations, charge carrier diffusion, digitization, etc..) which allow to estimate the performance of x-ray detectors with a fast execution time. The outcome of this extension will thus be of great added value in the rapidly-expanding field of digital radiography.

Presenter: MURPHY, Sebastien (ETH Zurich (CH))

Session Classification: Simulation Examples

Contribution ID: **7** Type: **not specified**

Allpix Squared Simulations of ATLAS ITk Strip Detectors

Tuesday 27 November 2018 14:25 (25 minutes)

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.

Presenter: MINANO MOYA, Mercedes (Instituto de Física Corpuscular (CSIC-UV))

Session Classification: Simulation Examples

Contribution ID: **8** Type: **not specified**

Combining TCAD and Monte Carlo Methods to Simulate High-Resistivity CMOS Pixel Detectors

Tuesday 27 November 2018 09:50 (25 minutes)

Combining electrostatic field simulations with Monte Carlo methods enables realistic modeling of the detector response for novel monolithic silicon detectors with strongly non-linear electric fields. Both the precise field description and the inclusion of Landau fluctuations and production of secondary particles in the sensor are crucial ingredients for the understanding and reproduction of detector characteristics.

In this contribution, a pixel detector produced in a High-Resistivity CMOS process is simulated by integrating a detailed electric field model from TCAD into a Monte Carlo based simulation with the Allpix Squared framework. The simulation results are compared to data recorded in test beam measurements and very good agreement is found for various quantities such as cluster size, signal charge, resolution and efficiency. Furthermore, the observables are studied as a function of the intra-pixel incidence position to enable a detailed comparison with the detector behavior observed in data.

The validation of such simulations is fundamental for modeling the detector response and for predicting the performance of future prototype designs. Moreover, visualization plots extracted from the framework's charge carrier drift model can aid in understanding the charge propagation behavior in different regions of the sensor.

Presenter: SPANNAGEL, Simon (CERN)

Session Classification: Simulation Examples

Contribution ID: **9** Type: **not specified**

Testing Particle Categorization Methods with the ATLAS-TPX Radiation Monitors

Tuesday 27 November 2018 09:25 (25 minutes)

Presenter: BILLOUD, Thomas Remy Victor (Universite de Montreal (CA))

Session Classification: Simulation Examples

Contribution ID: **10** Type: **not specified**

Validating Alignment Algorithms using Allpix Squared Simulations

Tuesday 27 November 2018 09:00 (25 minutes)

Presenter: ZAFFARONI, Ettore (Universite de Geneve (CH))

Session Classification: Simulation Examples

Contribution ID: **11** Type: **not specified**

The MALTA telescope: simulation and comparison with data

Tuesday 27 November 2018 14:50 (25 minutes)

MALTA is a monolithic active pixel sensor intended for implementation in the outer layers of the ATLAS pixel detector during the Phase-II upgrade. Monolithic active pixels produced in commercial CMOS technology have a number of advantages over hybrids sensors currently being used, including: improved granularity, lower material budget, lower power dissipation, and lower financial cost. The chip based on the ALPIDE chip, which is to be implemented in the ALICE experiment during the 2019-2020 long shutdown of the LHC.

We are developing a telescope consisting of six MALTA planes for test beam experiments. In this contribution, we show recent results from test beams at SPS and comparisons to AllPix simulations. In both we measure a spatial resolution near 4um. We also include results for 3GeV and 5GeV electrons in anticipation of test beams at DESY in 2019.

Presenter: FREEMAN, Patrick Moriishi (University of Birmingham (GB))

Session Classification: Simulation Examples