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WG4 Modelling of Physics Processes and Software Tools

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WG4 Modelling of Physics Processes and Software Tools

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Simulation Tools

Overview

- **Electric Field Map Calculations**: Ansys, Elmer (+Gmsh), NeBEM, COMSOL.
- **Electron transport in gas**: Magboltz
- **Simulation of Primary Ionization**: HEED, SRIM, Degrad
- **Toolkit for MPGD detector simulation**: Garfield (fortran), Garfield++ (C++)
- **GEANT4**: an interface to use Garfield++ classes in GEANT4 has been created and is explained here

When using which Tool?

While Ansys and COMSOL are commercial packages that implement the _Finite Element Method_ (FEM) and one has to buy a license to use this code, Elmer is an open-source program for FEM that can be used in combination with the open-source Gmsh program that can be used to create and mesh the geometry. Another approach to calculate the electric field in a gaseous detector is the _Boundary Element Method_ (BEM). An open-source implementation is NeBEM, which exists in a fortran version which is included in Garfield and in a C++ version, currently under development and which will be integrated in Garfield++. Furthermore wire-detectors have fields that often have analytical field solutions. In this case the electric field can be calculated either with Garfield as Garfield++.

Magboltz solves the Boltzman equation for an electron in a gas....

Simulation of Primary Ionization

Garfield vs Garfield++

Getting started?

- **Ansys**: excellent tutorial on Garfield++ webpage to simulate the Electric field in a Single-GEM here
- **Garfield++ and Heed++**: good examples on Garfield++ webpage: Simulating Energy Loss with Heed++here and an avalanche in a Single-GEM here.
- **Garfield**: good examples on Garfield webpage here

Main Research Topics

Maintenance & Development of Simulation Tools

Simulation of MPGD detectors
Open Issues

We are looking for interested and motivated people that can improve the simulation tools. There are several items where we have ideas on how to improve the simulation codes, but where we lack manpower:

- **Discrepancy in Gain between data and simulation in GEM-structures**: Simulation underestimates with a factor 2 (check) the gain in a single GEM-foil, and this propagates also to multi-GEM structures. More information can be found [[][here (insert link)]. A possible candidate for this under-estimation of the gain is the fact that the Electric field changes substantially within the volume of a mesh element. Garfield(++) however takes the central value and asks Magboltz to calculate the Mean Free Path before collision. If the electric field varies strongly, the mean free path is over-estimated and the multiplication factor (e-/cm) is under-estimated. A possible solution continue

- **Reading COMSOL fieldmap in Garfield++**: Garfield++ has only a function to read a COMSOL fieldmap made of first-order elements (tetraeders with 4 nodes), while more accurate results could be obtained with second order elements (tetraeders with 10 nodes), because these second order elements allow a more precise meshing of volumes with convex or concave structures. Instead the fortran version of Garfield is able to read 2nd order element fieldmaps.

- **Update Magboltz in Garfield++**: Garfield++ is interfaced with Magboltz 10.1 (%REDcheck), while the latest version is 11.6 (Nov 2018).

- **Update HEED in Garfield++**: the version of HEED actually implemented in Garfield++ does not simulate the Coulomb scattering when passing through a material. Furthermore the specific primary ionisation is calculated based upon the initial kinetic energy of the particle and is not updated if the particle looses energy inside the detector. While this works fine for a Minimum Ionizing Particle passing through a thin absorber, this does not work for layered detectors where some material needs to be perforated or for the simulation of sub-relativistic electrons that loose energy at much higher rate than a MIP and might get stopped in the detector.

— PietVerwilligen - 2019-01-20

This topic: MPGD > WG4-Simulation
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