Simulation of a MicroMegas detector for low-energy α-particle and fission fragment tracking using Garfield++

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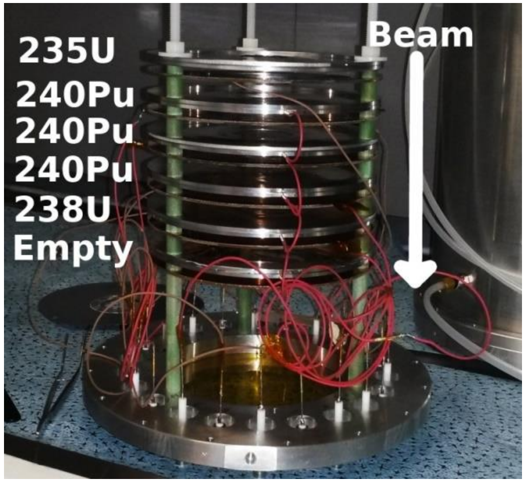
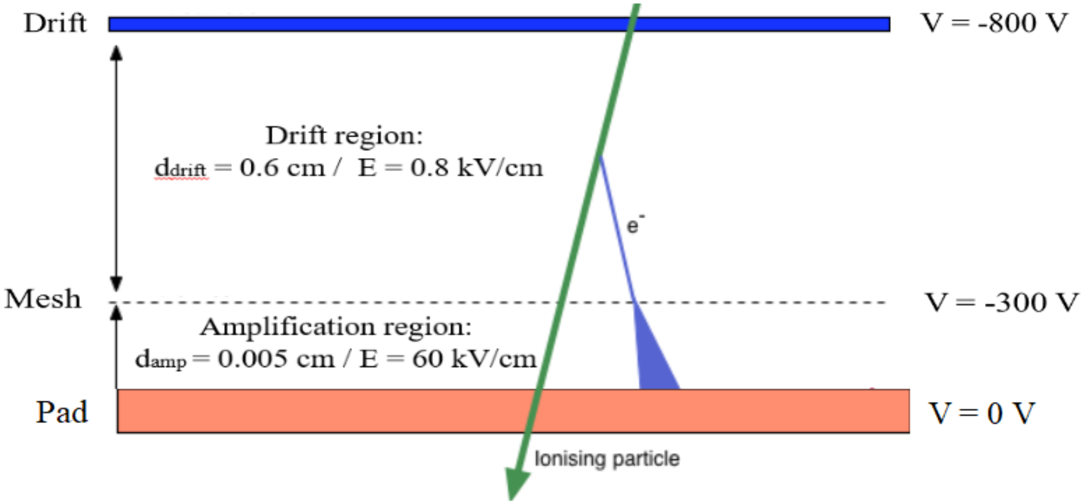
Motivation

- Usage of Garfield++ for the needs of nuclear physics.
- Maybe the best toolkit for gaseous detectors simulation due to :
    1. Monte Carlo calculations combining the microscopic approach for the tracking of the produced electrons, with the macroscopic and the semiclassical ones for ion tracking and for the calculation of the electrons' transport parameters respectively.
    2. Variety of options concerning the accurate description of the detector geometry, materials and signal calculation.
    3. Compatibility with other programs, using tables computed by SRIM for the simulation of ion tracks. It also imports finite-element field maps calculated using COMSOL, ANSYS and Elmer.
- Developed in CERN and linked with ROOT, Garfield++ has an active supporting community.
- Final goal: Code development for basic geometries and gases used in nuclear physics applications

Method

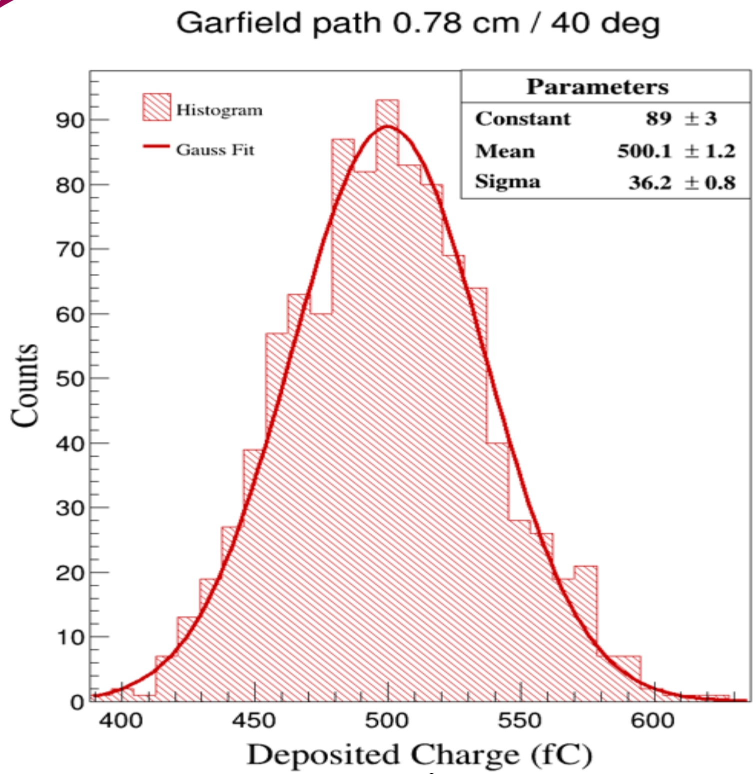
- To approach the problem, a simplified MicroMegas geometry was used. The cylindrical electrodes are replaced with infinite planes.

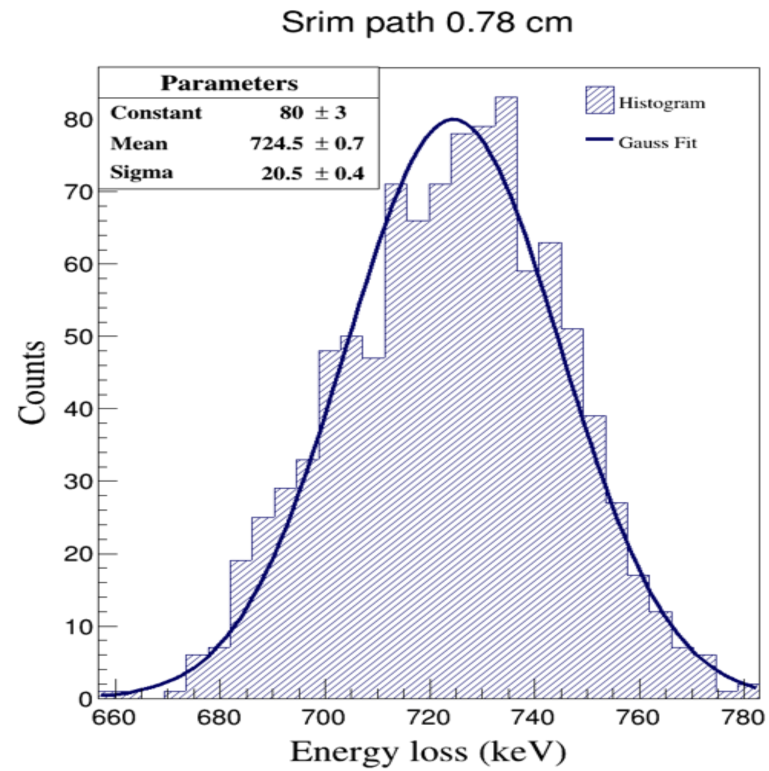


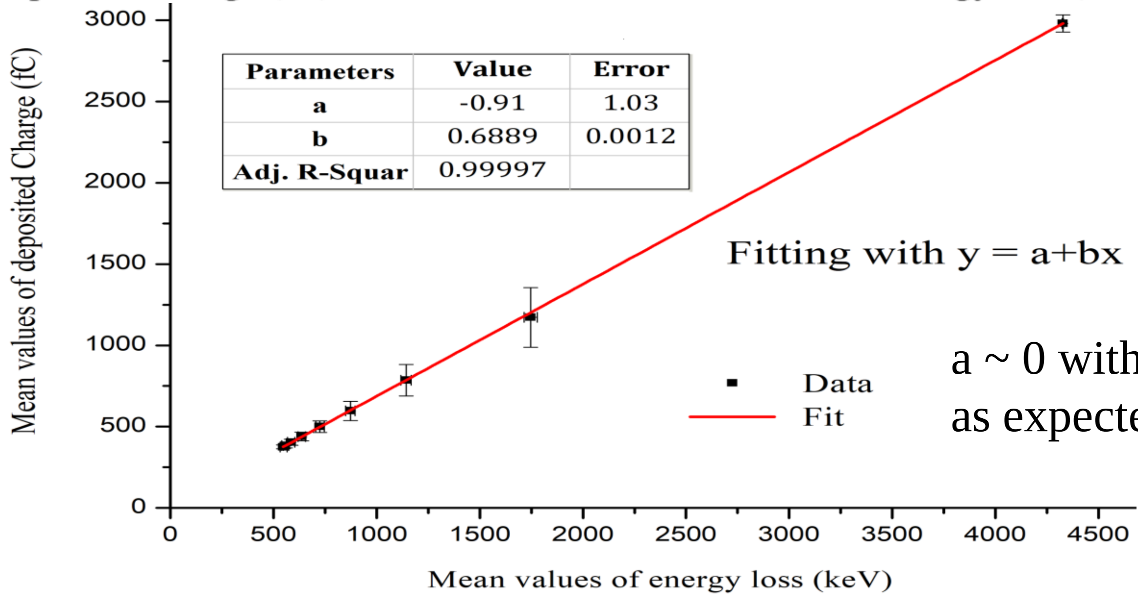


- First step: proof of the detector´s linear response to energy:
  1. Collection of simulated data for the deposited charge in the anode electrode for different particle trajectories.
  2. Comparison with the corresponding results obtained by SRIM2013 regarding the α-particle energy losses inside the detector, using the same set of parameters.
  3. A linear relation between the deposited charge and energy is expected.

Results 1/2





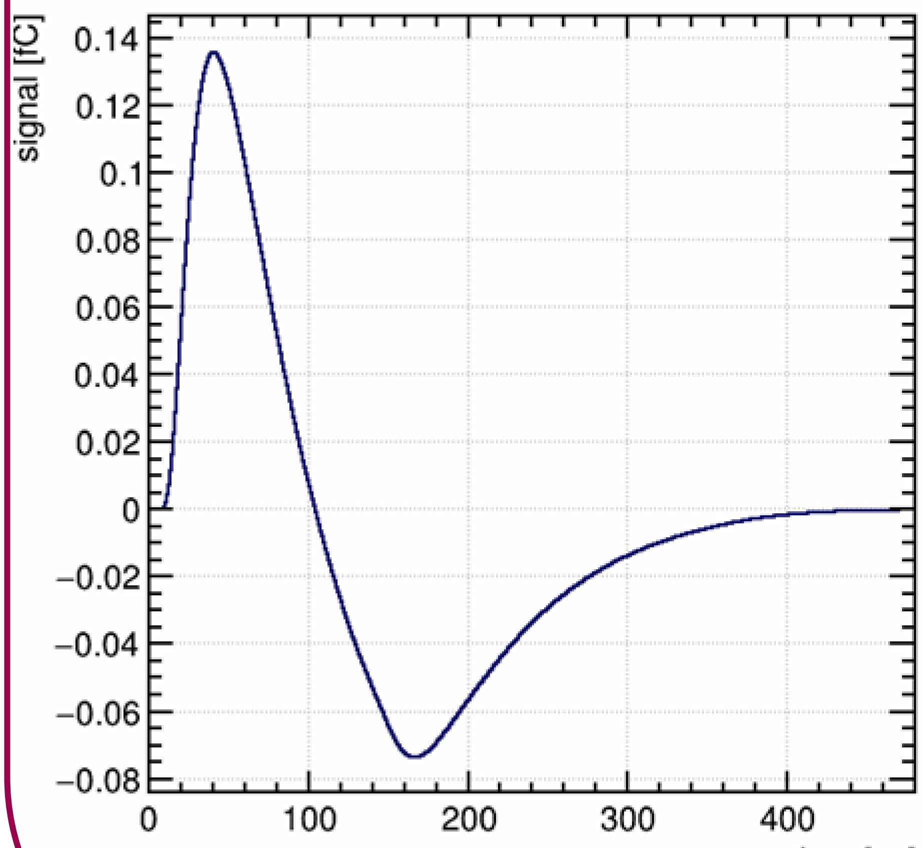


a ~ 0 within error,
as expected!

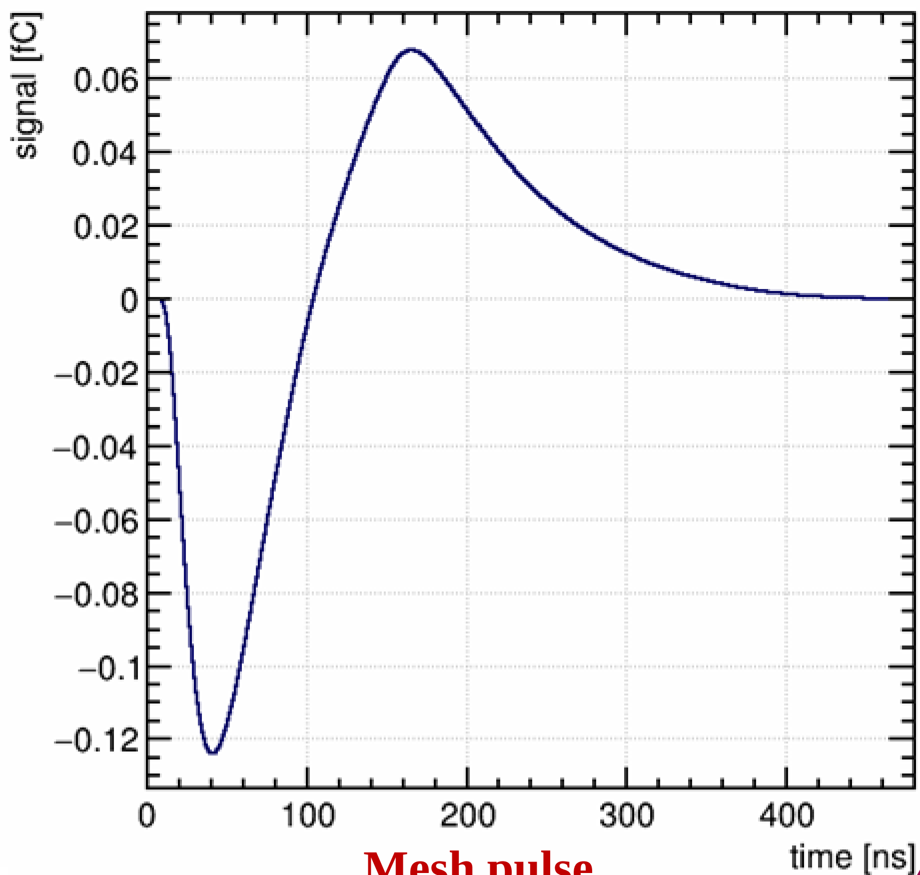
Results 2/2

- The deposited charge was computed as the integral of the signal over time,long enough, for both ions and electrons to be collected.

Time evolution of a MicroMegas pulse



Drift pulse



Mesh pulse

Conclusions

- The similarities between SRIM's and Garfield++'s Gauss distributions show that the toolkit is reliable for detector resolution studies.
- The highly linear behavior between the deposited charge and the energy loss of alphas in the experimental environment is quite encouraging.

Future perspectives

- Development of more complicated 3D geometries.
- Continuation with low energy fission fragments.
- Creation of a user-friendly interface for the purposes of nuclear physics studies.
- Code optimization for the needs of experimental nuclear physics studies.