Garfield Simulation of CGEM

Miao Nannan

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Outline

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- Lorentz Angle
- Electron shift(mean) and size(RMS)
- Primary ionization
- Avalanche & Gain
- Signal (Ongoing)

Introduction

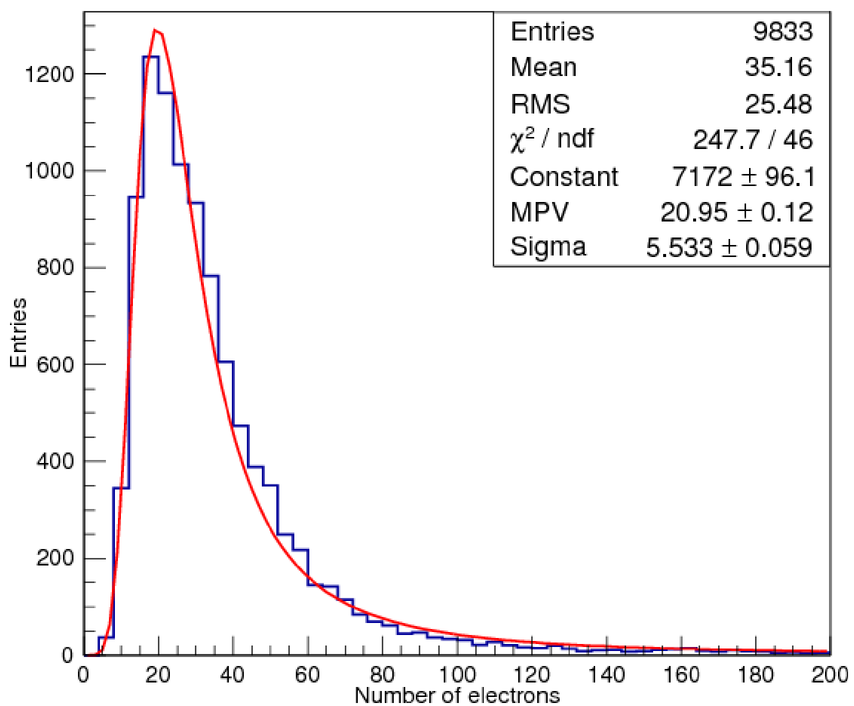
- Garfield is time consuming for the full triple-GEM simulation. So we will simulate the three GEMs separately.
- The incident particle interacts with gas and creates primary electrons.
- For “electron cluster”, it refers to the energy loss in a single ionizing collision of the primary charged particle and the secondary electrons produced in this process.

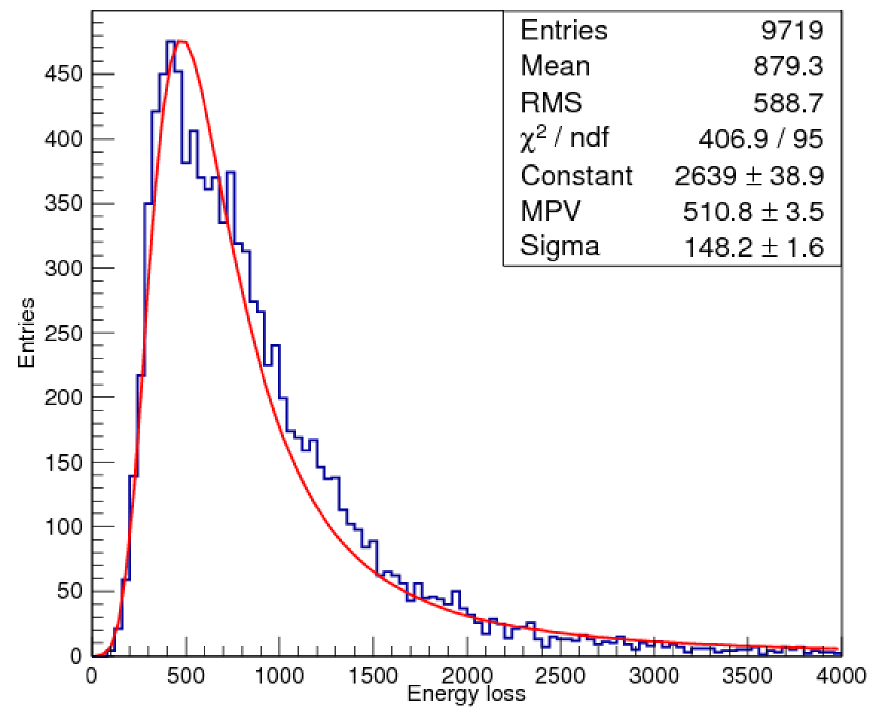
Method

- Software
  - ANSYS: to model & mesh the GEM
  - Garfield++: to simulate electron avalanches
  - ROOT and C scripts: to analyse the data
- Garfield Simulation
  - Gas Mixture: Ar: iC4H10 (90: 10)
  - Avalanche Model: AvalancheMicroscopic
  - Particle: 10k orthogonal $\boldsymbol{\mu}$ tracks with momentum $1\mathrm{Gev/c}$ for primary electrons simulation. 20k electrons for electron avalanches simulation.
  - Magnetic Field: 1Tesla
  - High voltages on foils : 270V/GEM
  - Field: 1.5/3/3/5 kV/cm (Drift/Transfer1/Transfer2/Induction)

Primary ionization

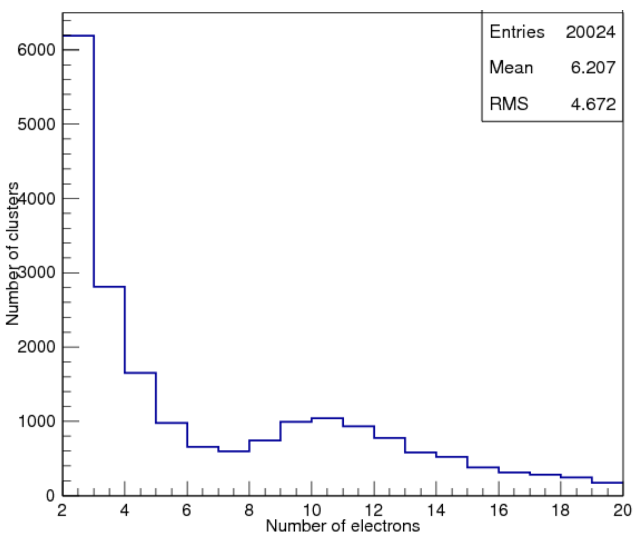
Total number of electrons and energy loss in drift area (~5mm), is Landau distribution.



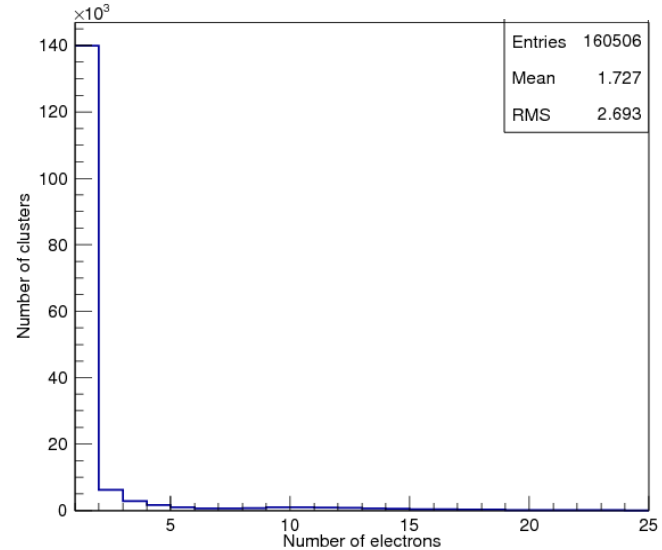


Primary ionization

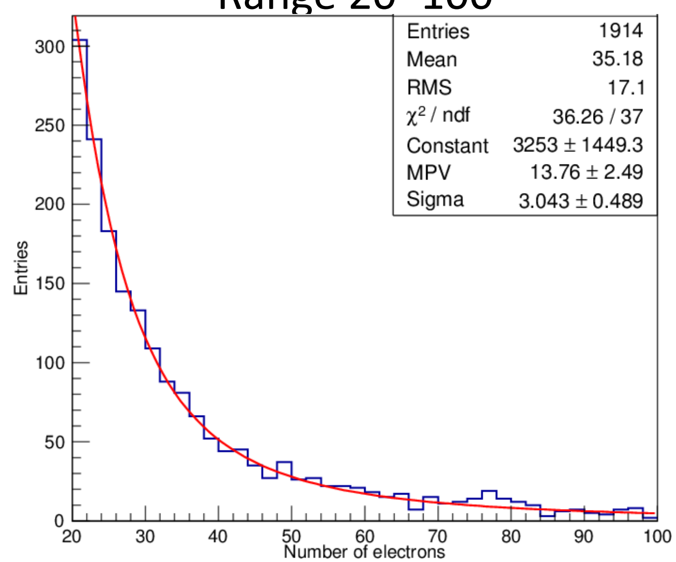
Range 2~20



Range 1~25



Range 20~100

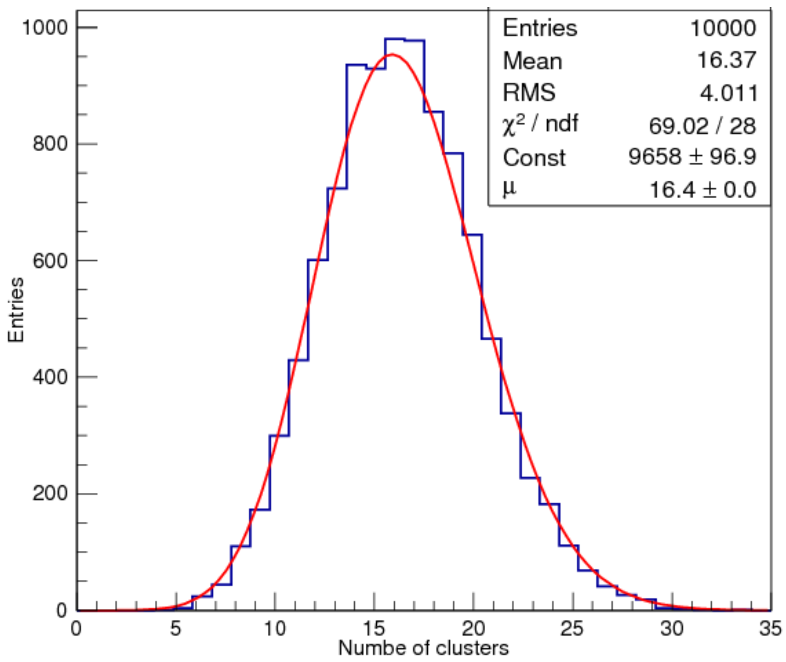


Number of Electrons in a Cluster in drift area (~5mm).

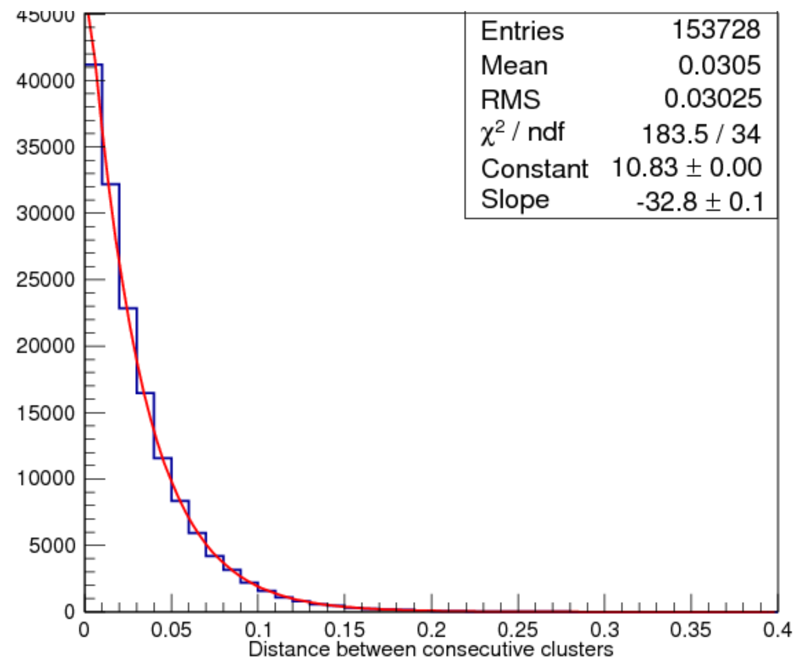
For range 20~100, the sampled value from the Landau fit.

Primary ionization

Number of Clusters in Drift Area

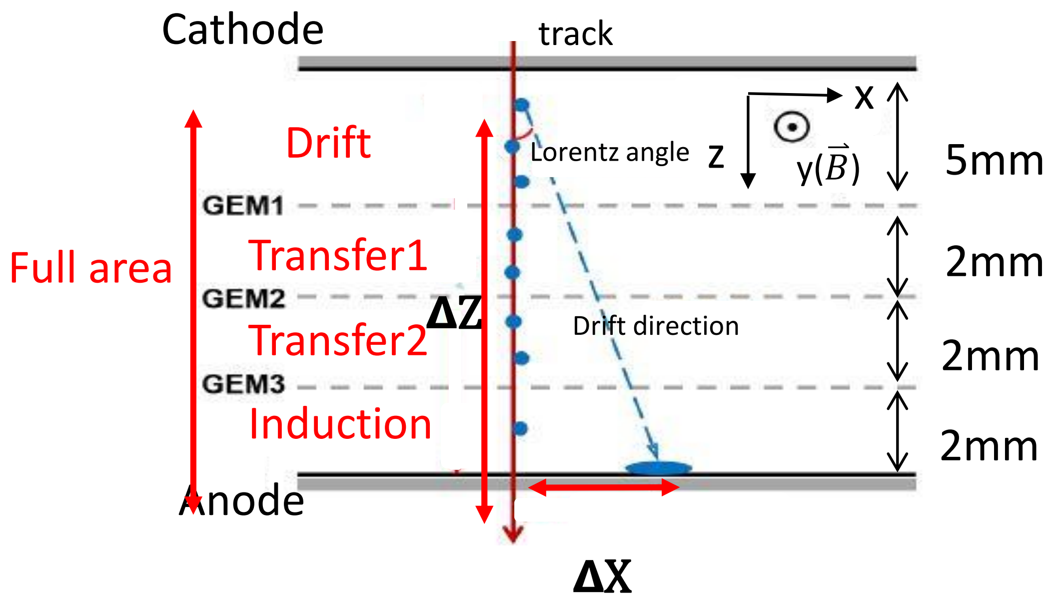


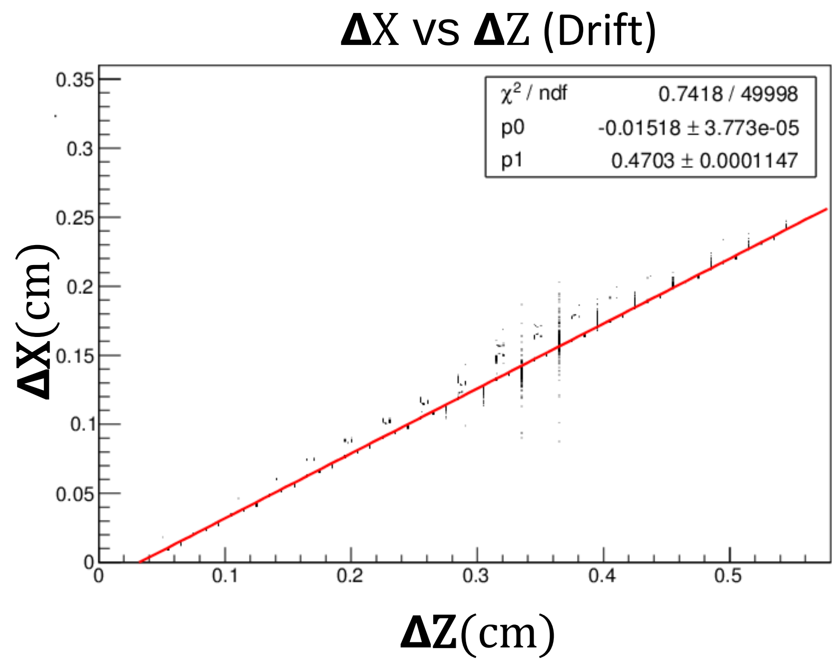
Distance Between Consecutive Clusters



In drift area (~5mm) , the produced electron clusters is a Poisson distribution.
An Exponential probability gives the distance between two consecutive clusters.

Lorentz Angle





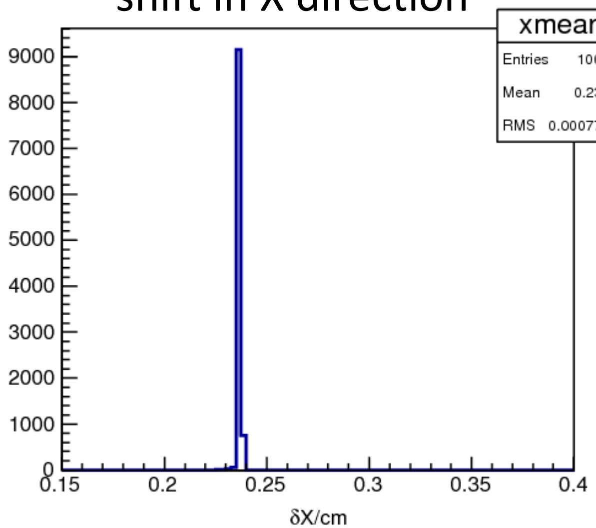
- In each area, simulate 1000 electrons separately in 50 equidistant bins.
- X is the direction which is perpendicular to E and B
- Z is the direction of electric field
- The Lorentz angle can be extracted from the plot

	Drift	Transfer1	Transfer2	Induction	Full area
Lorentz Angle	25.2	10.5	10.5	6.0	16.1
Electric Field (kV/cm)	1.5	3	3	5	

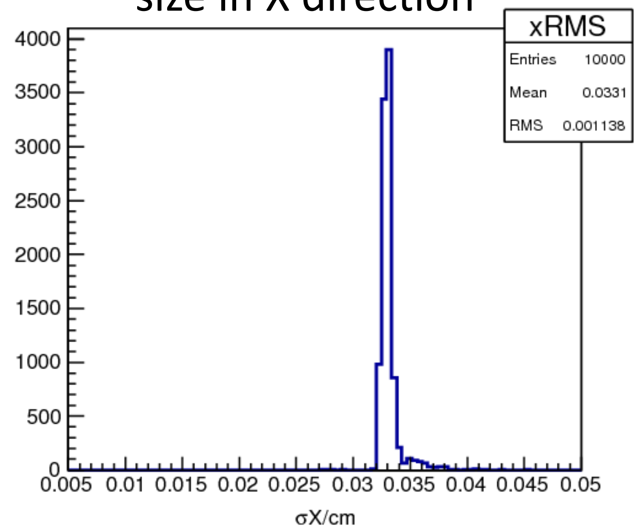
Electron shift(mean) and size(RMS)

Simulate 10k electrons in drift area(only drift and diffusion).

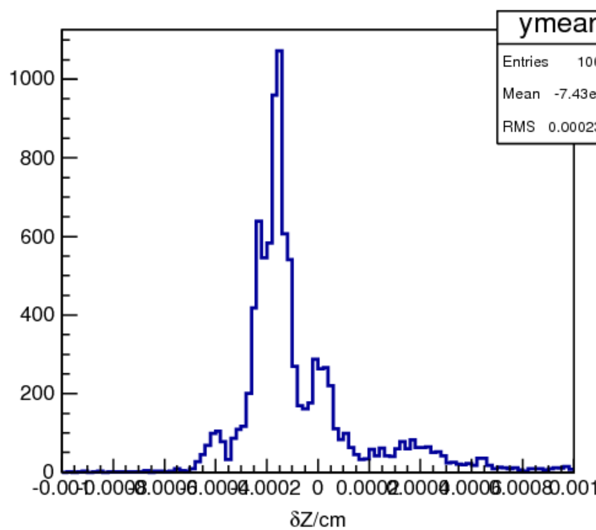
shift in X direction



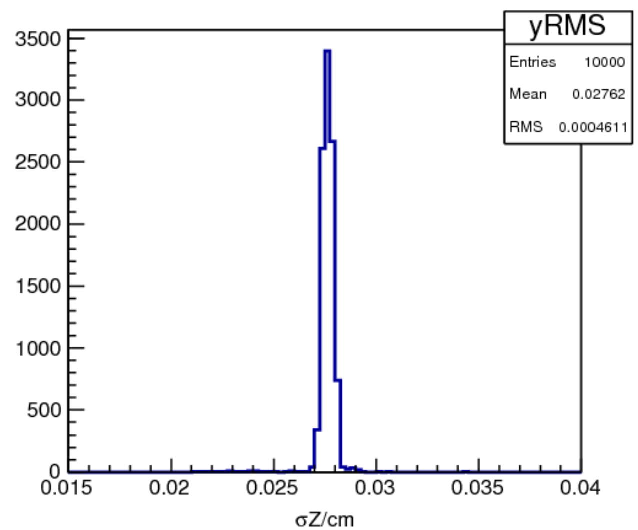
size in X direction



shift in Z direction



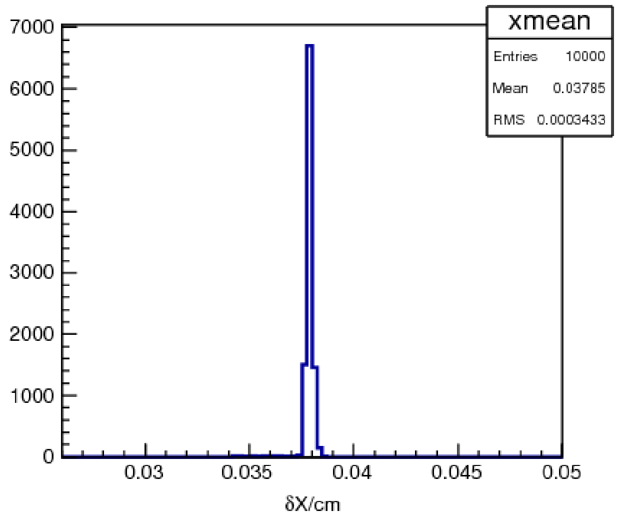
size in Z direction



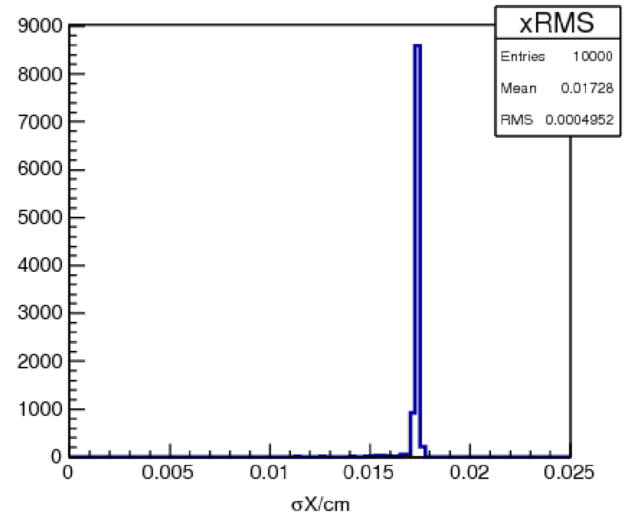
Electron shift(mean) and size(RMS)

Simulate 10k electrons in transfer1(only drift and diffusion).

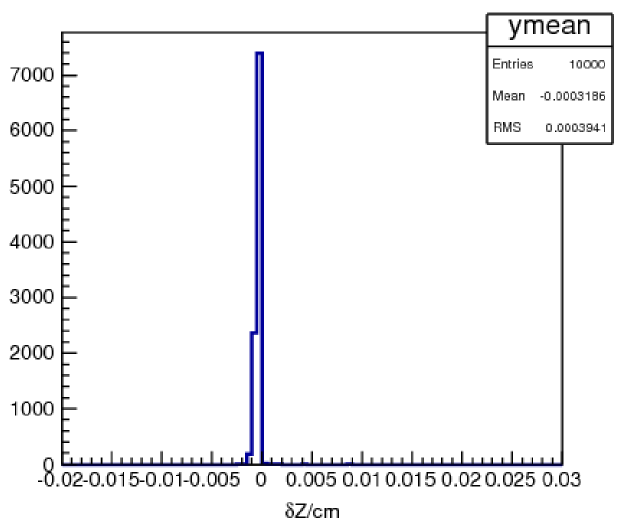
shift in X direction



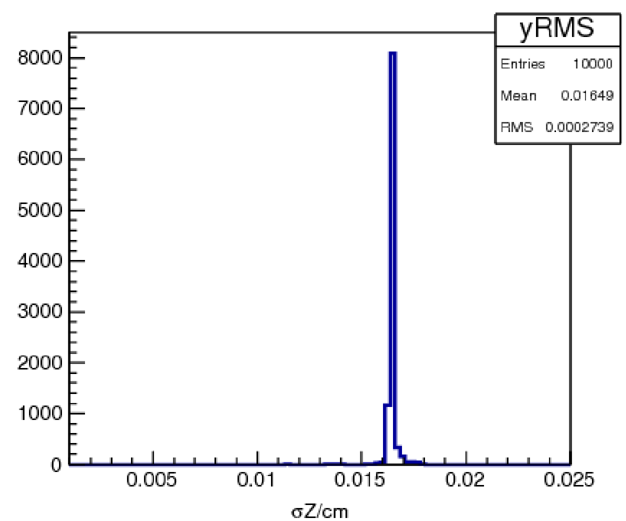
size in X direction



shift in Z direction



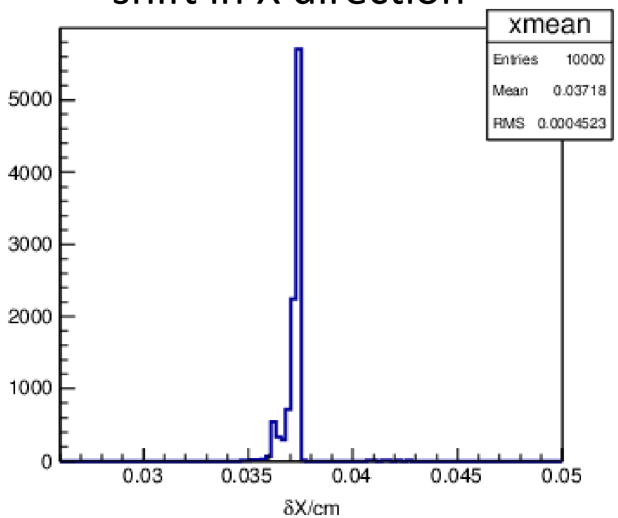
size in Z direction



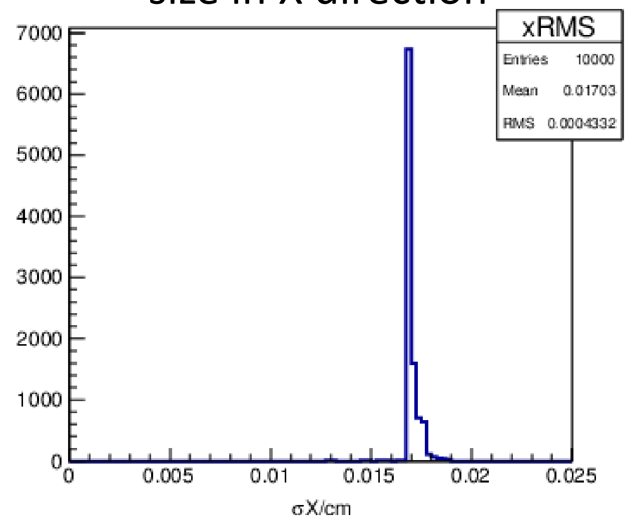
Electron shift(mean) and size(RMS)

Simulate 10k electrons in transfer2(only drift and diffusion).

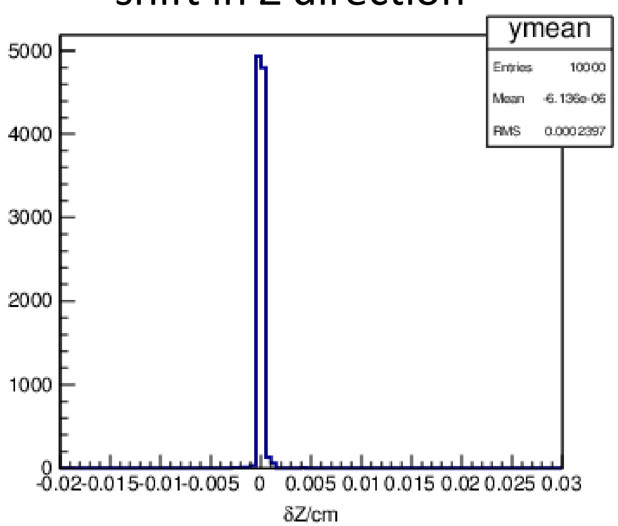
shift in X direction



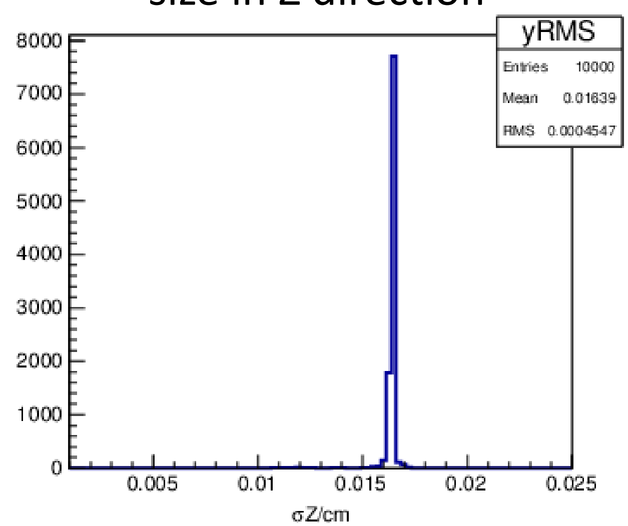
size in X direction



shift in Z direction

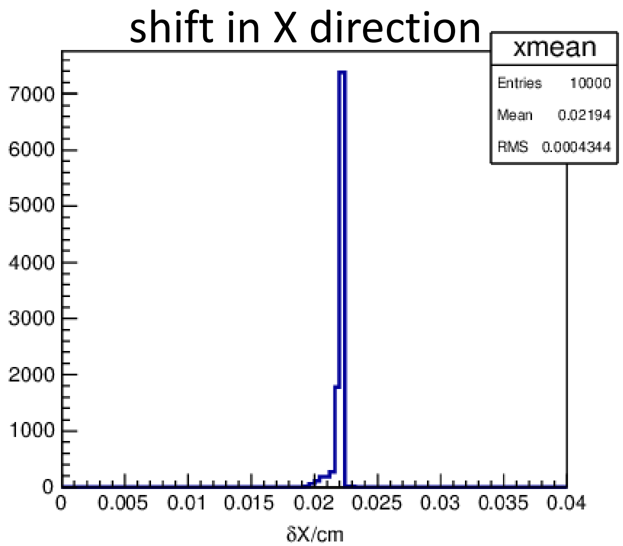


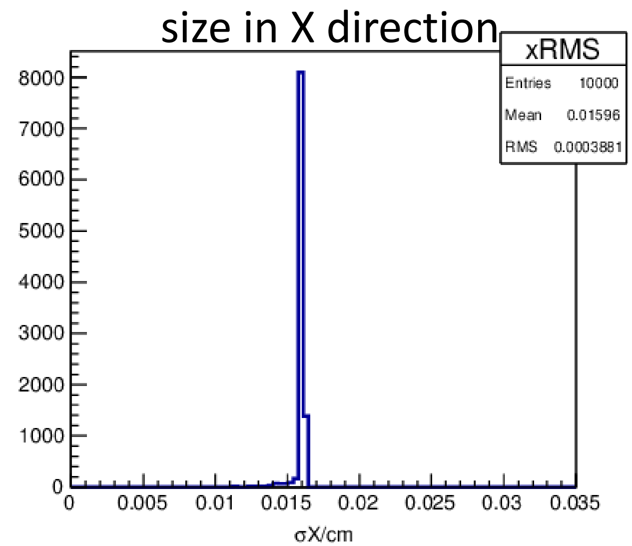
size in Z direction

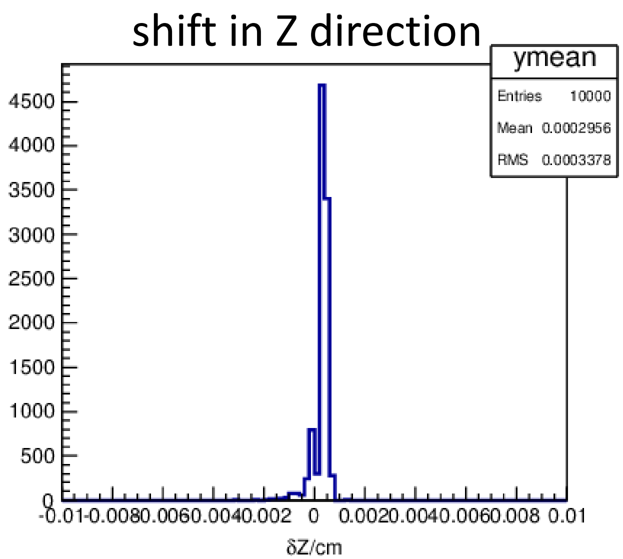


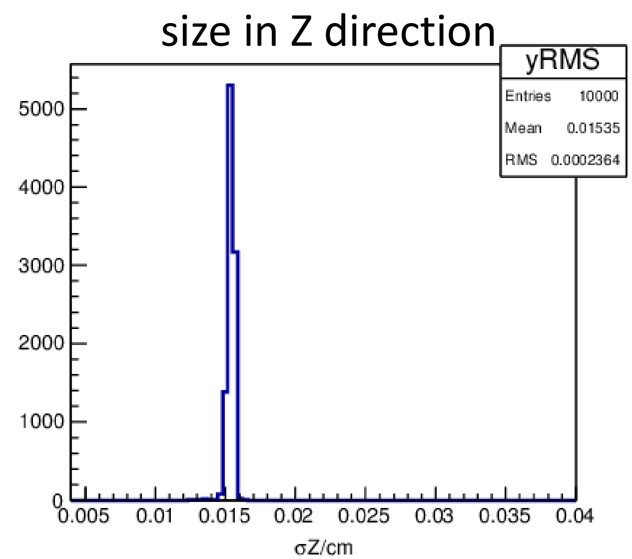
Electron shift(mean) and size(RMS)

Simulate 10k electrons in induction area(only drift and diffusion).





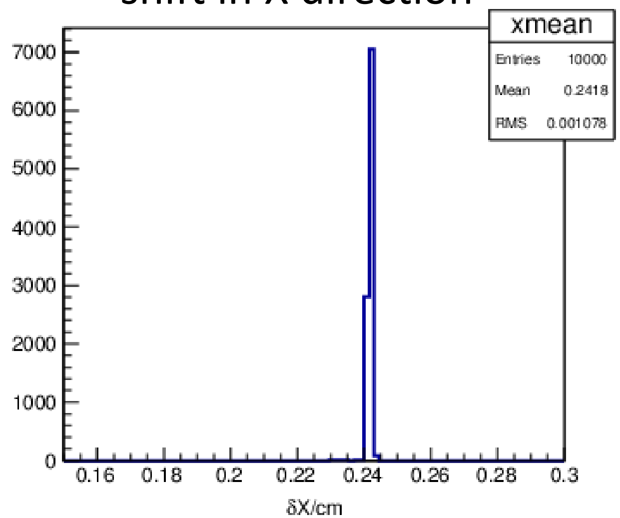




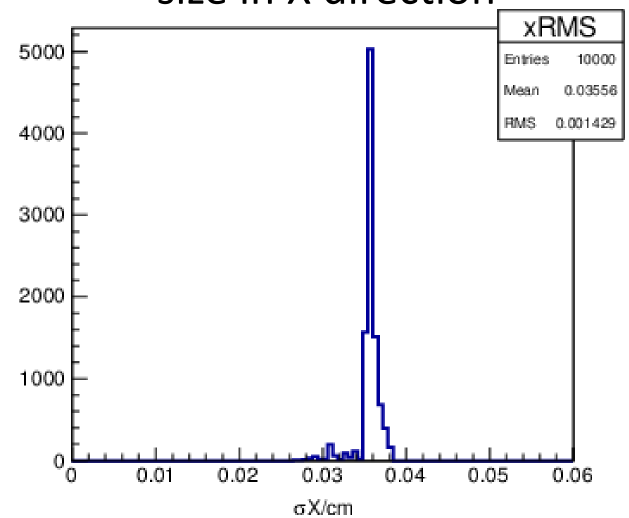
Electron shift(mean) and size(RMS)

Simulate 10k electrons in full area(only drift and diffusion).

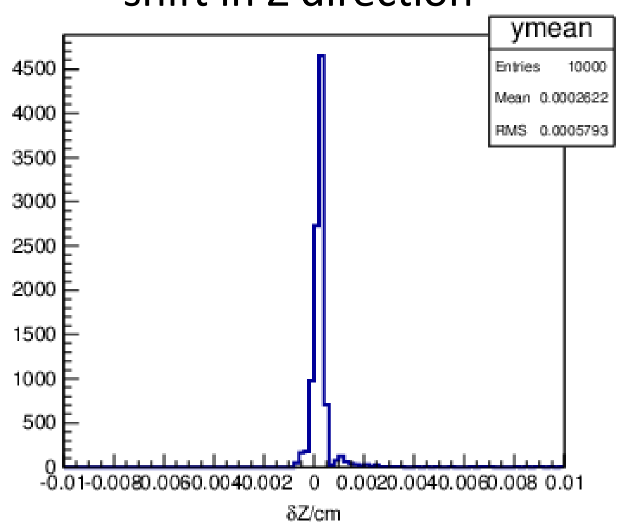
shift in X direction



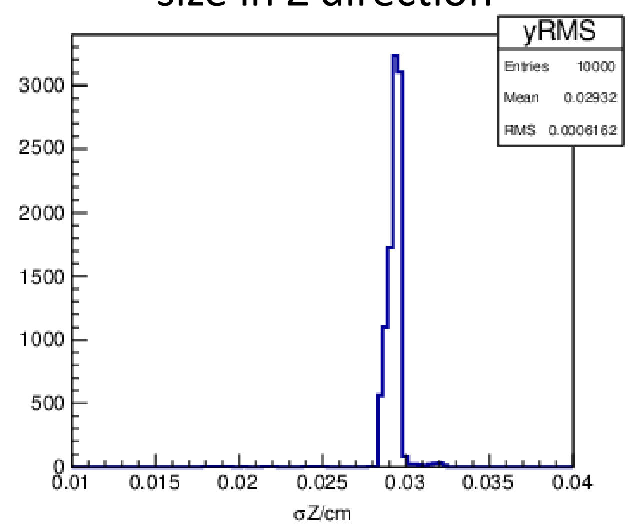
size in X direction



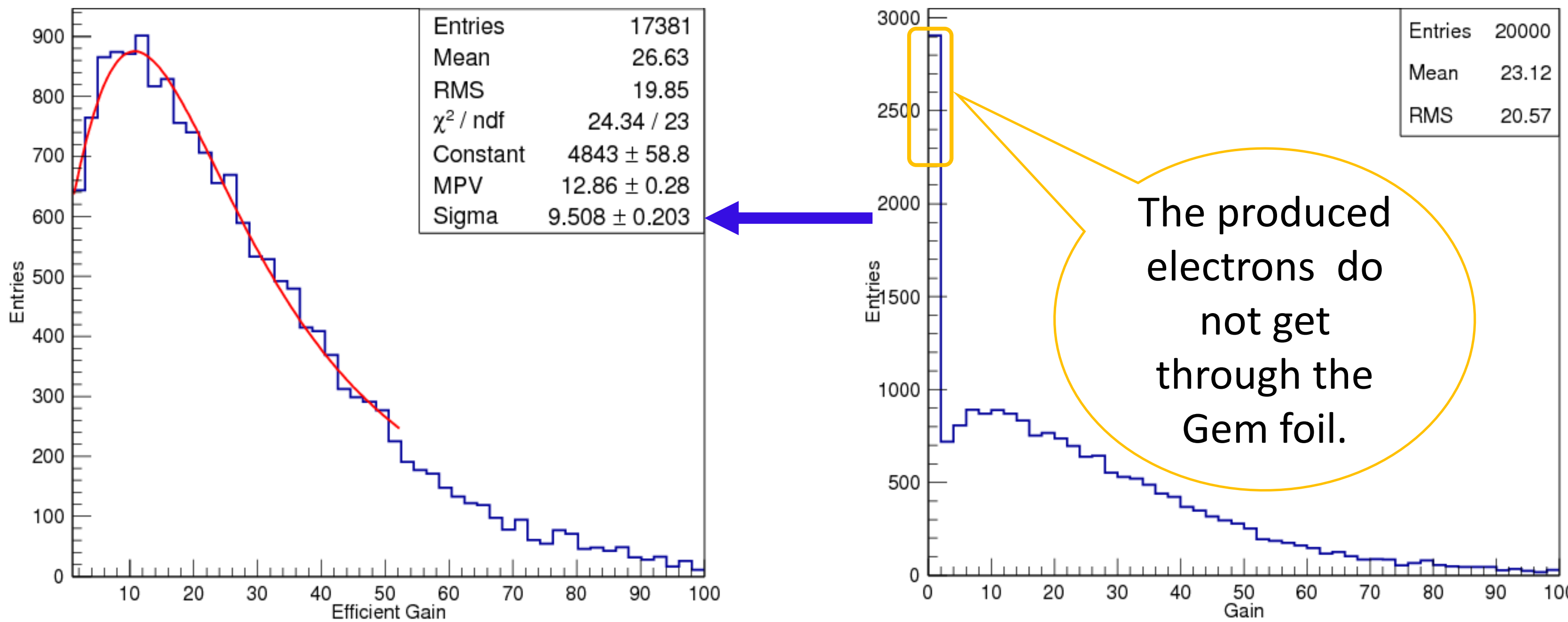
shift in Z direction



size in Z direction

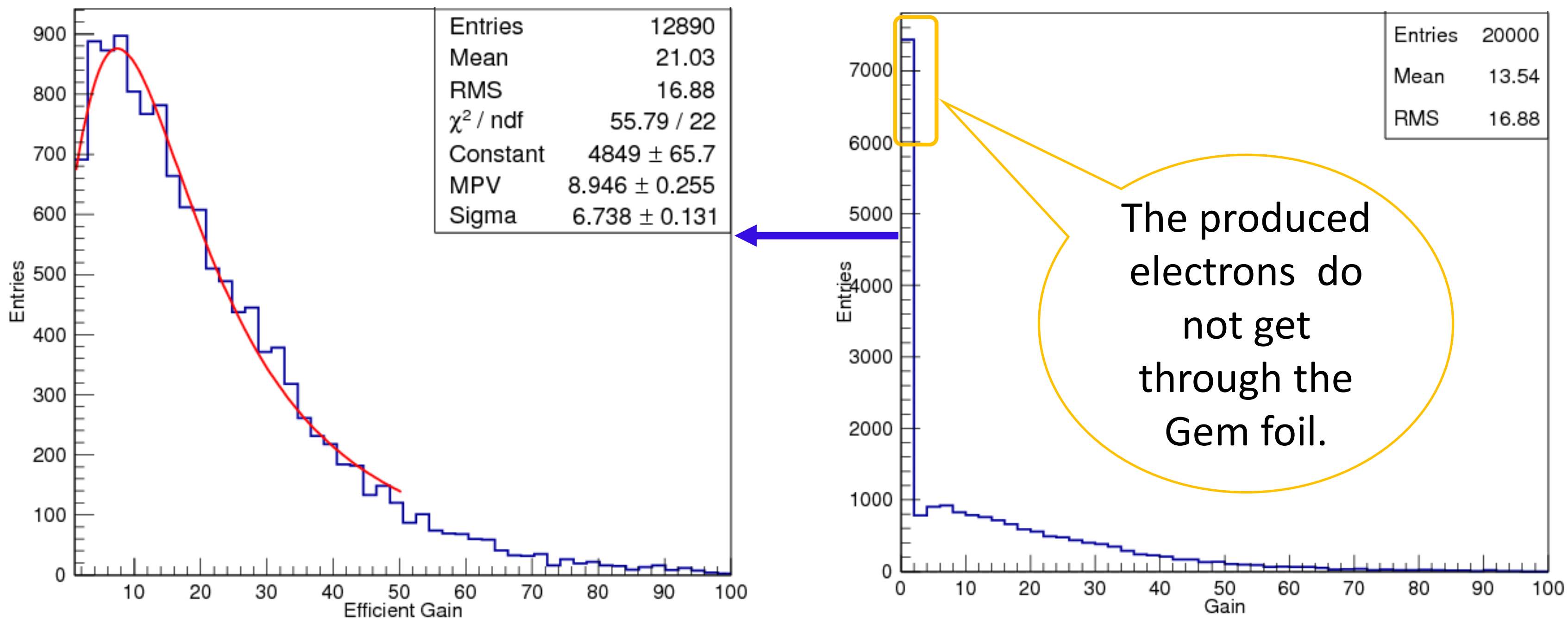


Avalanche & Gain ----Gem1



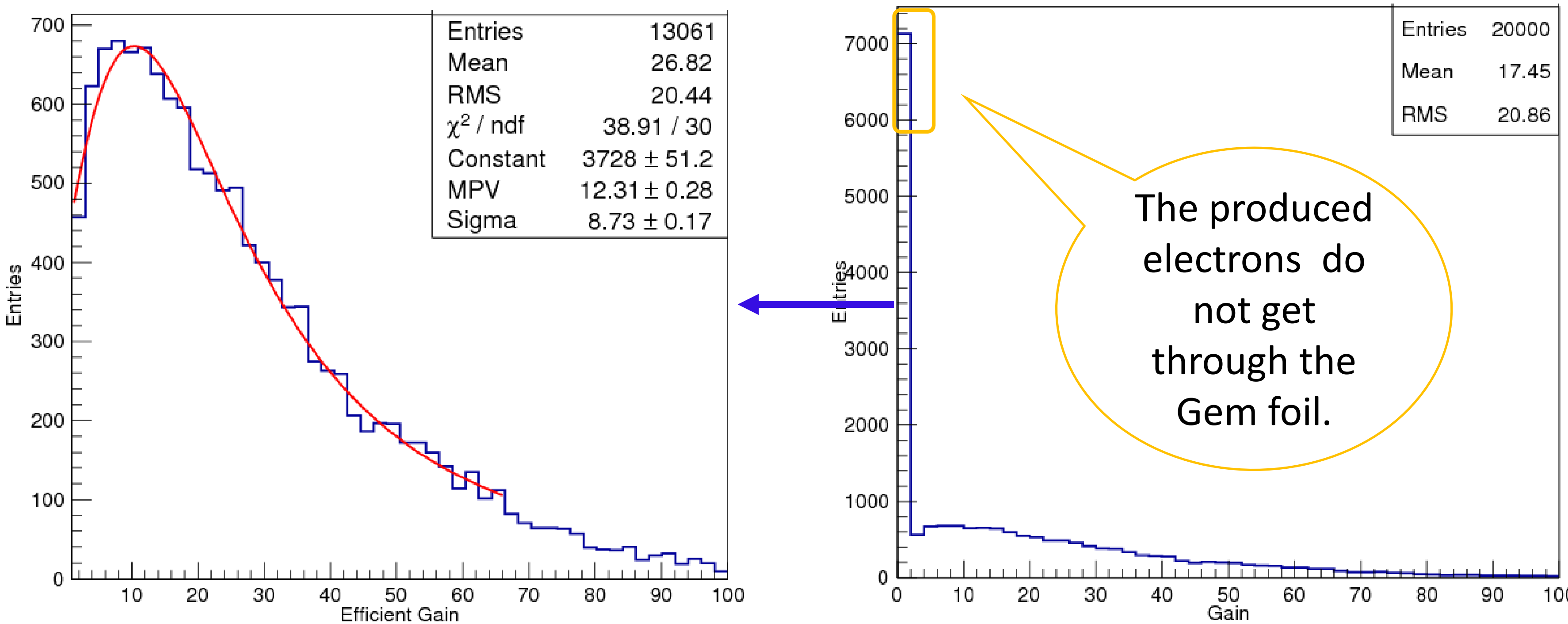
- Set an electron 150 μm before the Gem foil and count multiplied electrons 150 μm after the foil.
- Efficient gain: Electrons get through the Gem foil, about 86.9%. It is sampled from a Landau.

Avalanche & Gain ----Gem2



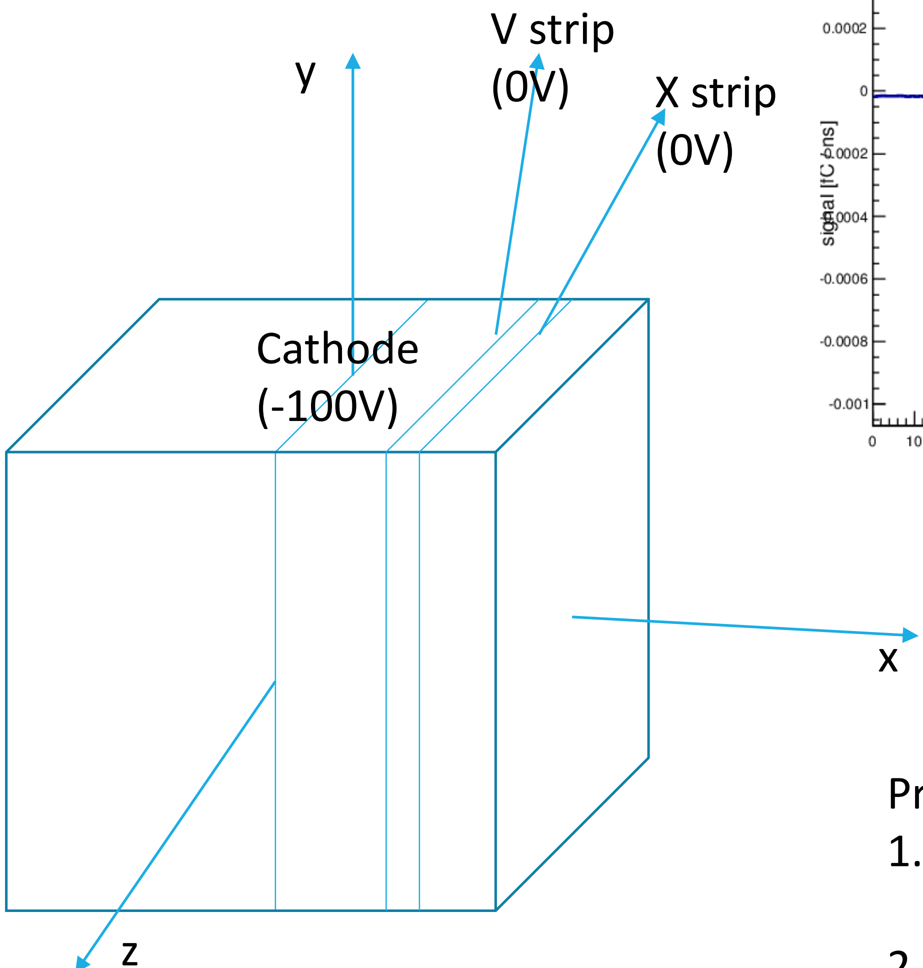
- Set an electron 150 μm before the Gem foil and count multiplied electrons 150 μm after the foil.
- Efficient gain: Electrons get through the Gem foil, about 64.5%. It is sampled from a Landau.

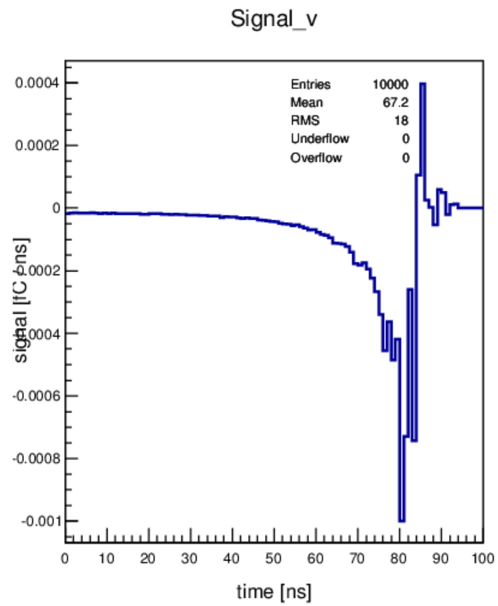
Avalanche & Gain ----Gem3

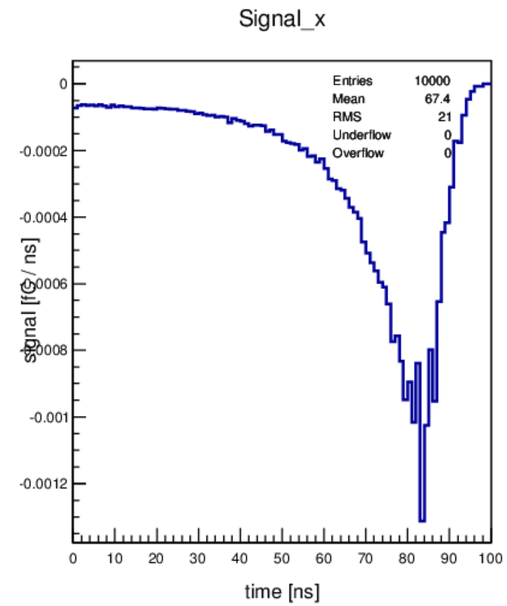


- Set an electron 150 μm before the Gem foil and count multiplied electrons 150 μm after the foil.
- Efficient gain: Electrons get through the Gem foil, about 65.3%. It is sampled from a Landau.

Signal (Ongoing)







The above plot is signal of one electron in 100 V_strips and 100 X_trips.

Problem:

1. The X and V strips can only be constructed in perpendicular direction.
2. Can't construct Gem foil, just a plane.