# Status of Mini Drift Tube digitization for PANDA ROOT

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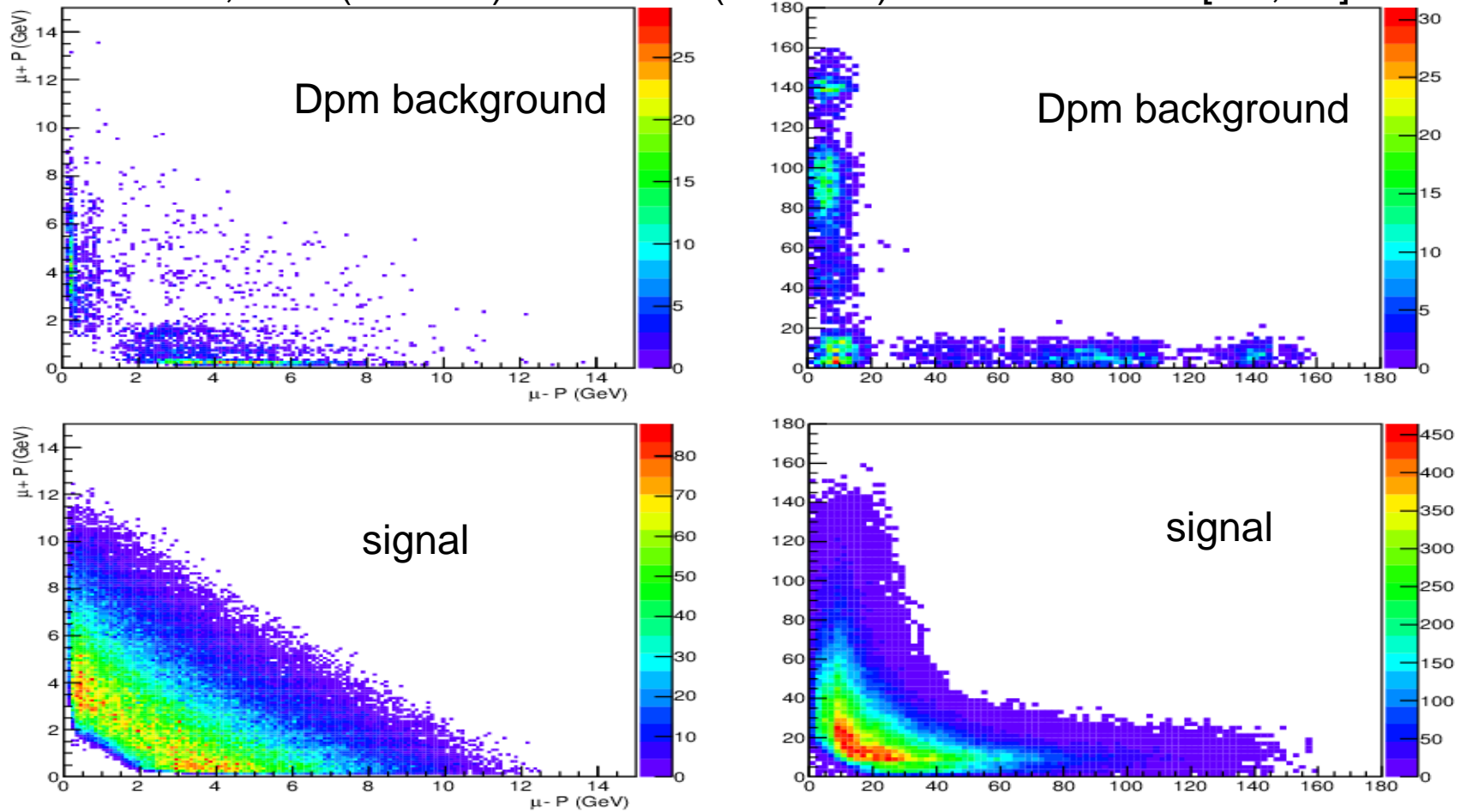# Motivation

- **To Study Drell-Yan**, Pythia 8175
  - 250K events, 500000 muons.
  - Hard QCD sub-process   [off]
  - qqbar→ gamma*/Z0→mu+mu-   [on]
  - Pdf of Proton, CTEQ6L1, LO.
  - 15GeV anti-proton beam.

- Background, PndDpmDirect
  - 5M events
  - 15GeV ant-proton beam.

- Panda ROOT,
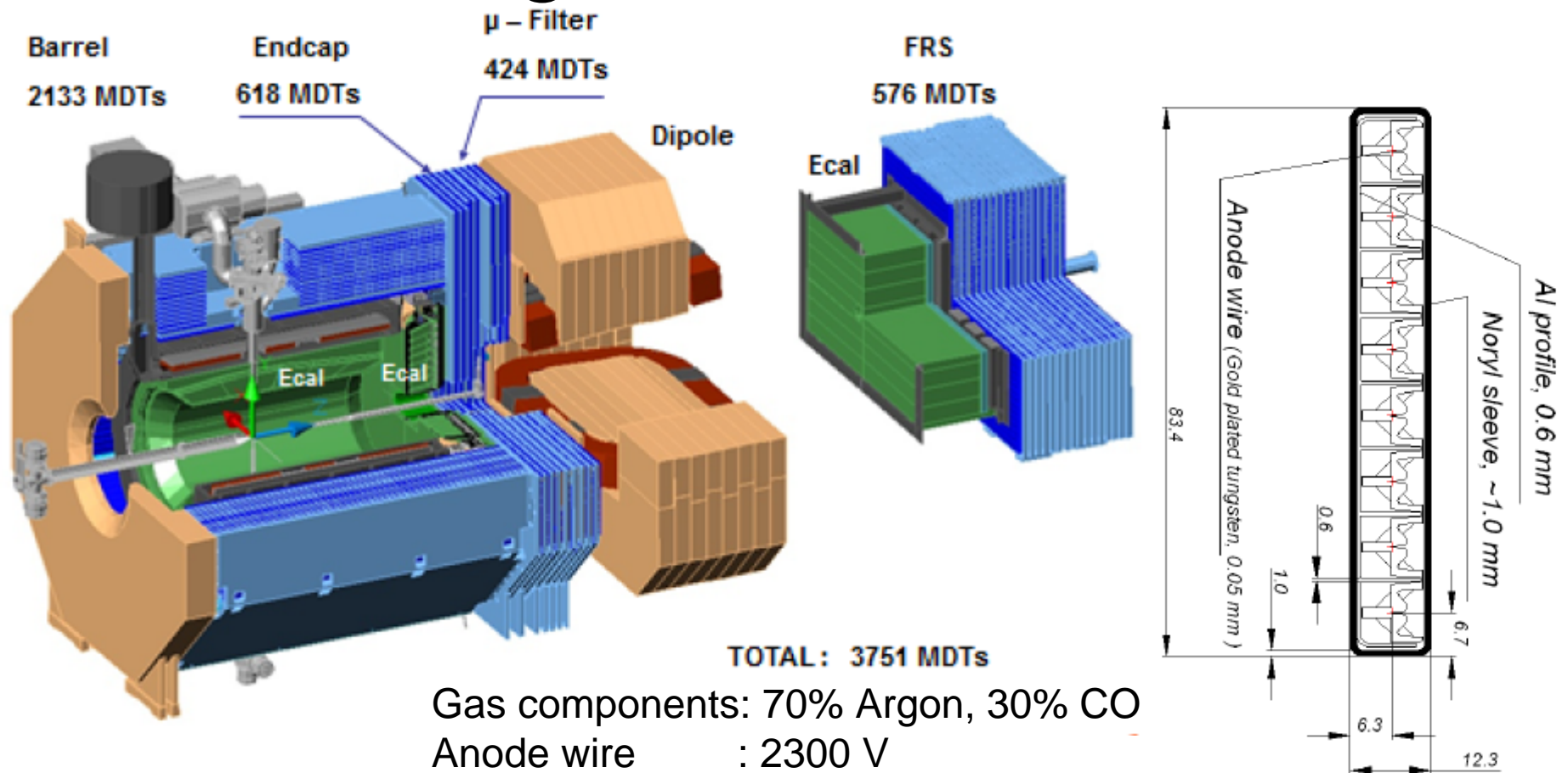 - The PndFastSim package of Scrut14.
  - Full detector setup.
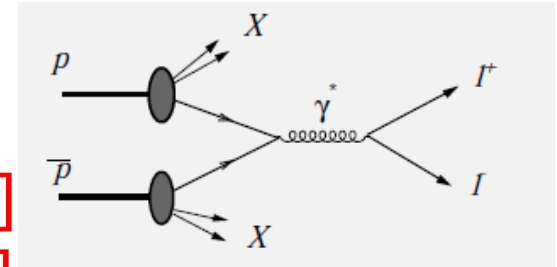
Background VS Signal

5M events, 3471(0.069%) left after M(mu+mu-) mass constraint [1.5,2.5] GeV

Fast Simulation and Reconstruction without time stamp.

Configurations of MDT

Barrel
2133 MDTs

Endcap
618 MDTs

μ – Filter
424 MDTs

Dipole

FRS
576 MDTs

Ecal

Ecal

Ecal

TOTAL: 3751 MDTs

Gas components: 70% Argon, 30% CO
Anode wire   : 2300 V
Temperature   : 300K
Pressure   : 1 atm
Readout   : Fired Yes/No

Anode wire (Gold plated tungsten, 0.05 mm)

Noryl sleeve, ~1.0 mm

Al profile, 0.6 mm

83.4

0.6

1.0

6.7

6.3

12.3
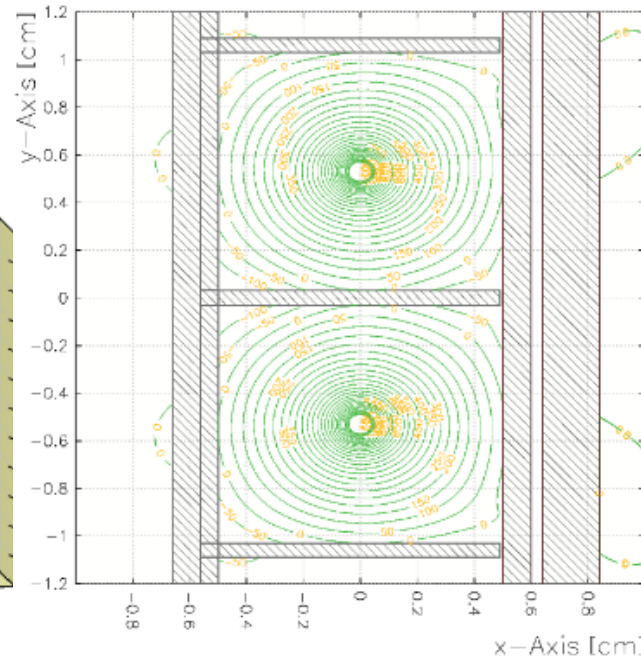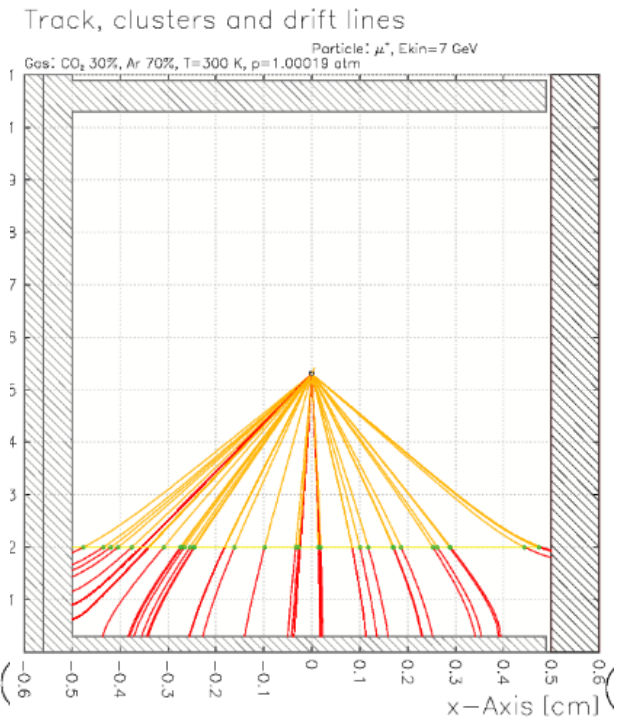
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Digitization Study

- Garfield is used to simulate MDT response to charged muons of different momentum.
- Geometry and Gas properties conform with Panda Muon TDR (final version).
- Calibration and Comparison with experimental measurements
- Parameters are extracted for the parameterized simulation..
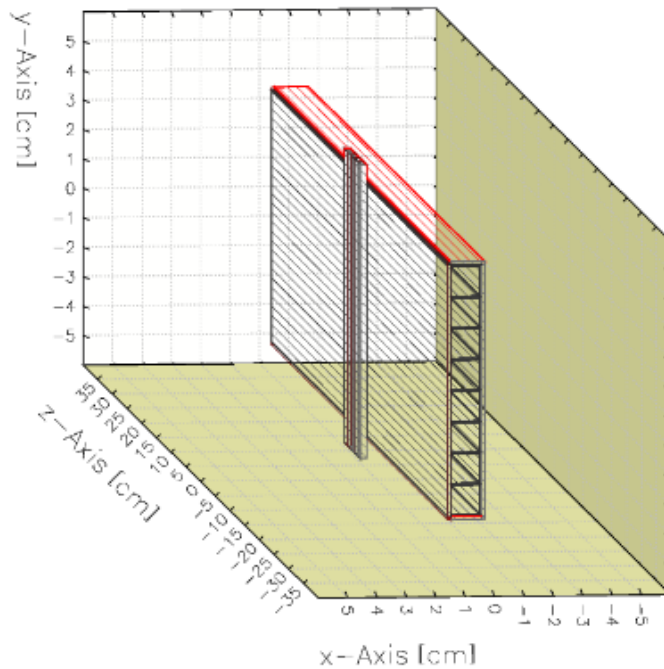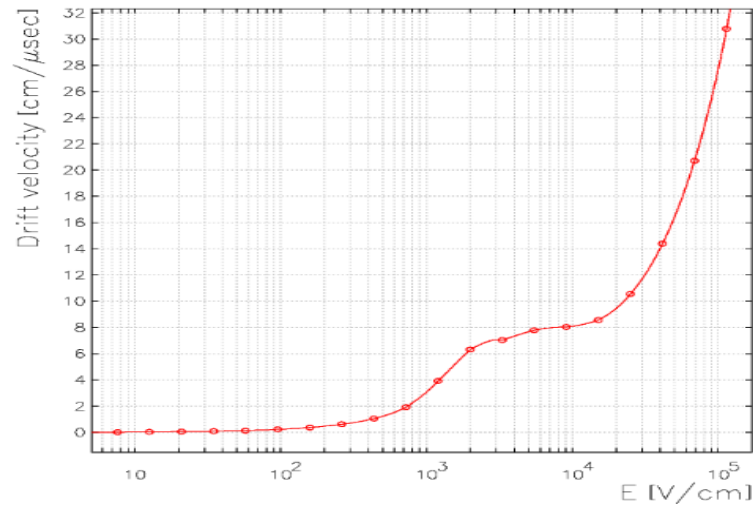

8 MDT tubes, 6 strips

Electric Field

7GeV muon-

Digis with time-stamp are what we want.
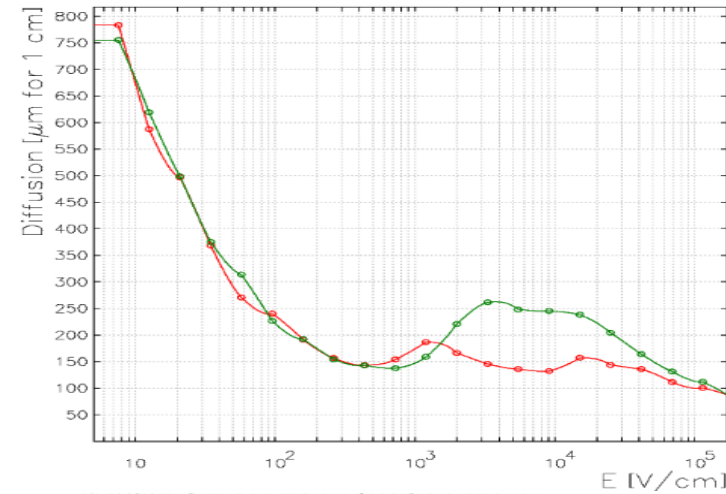
Gas Property From Magboltz
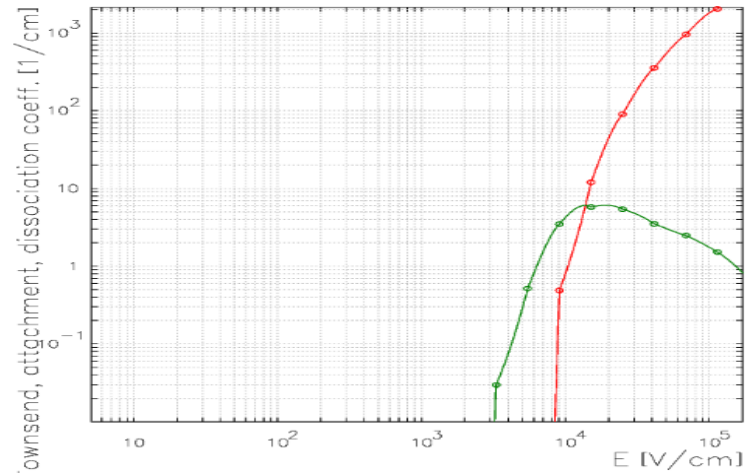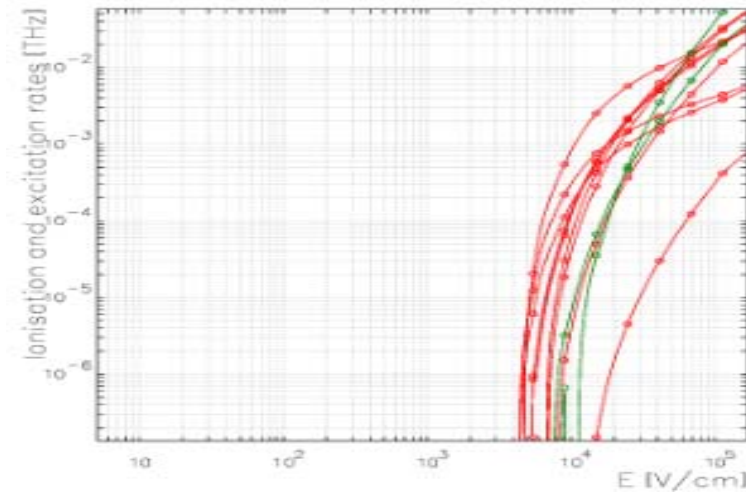
Clusters Generation in Heed

Size of clusters

Number of clusters in one track

Deposited energy per cm
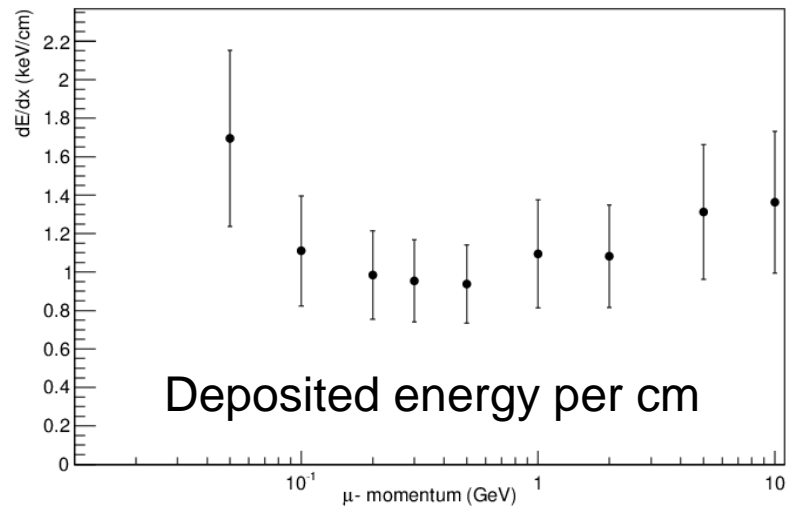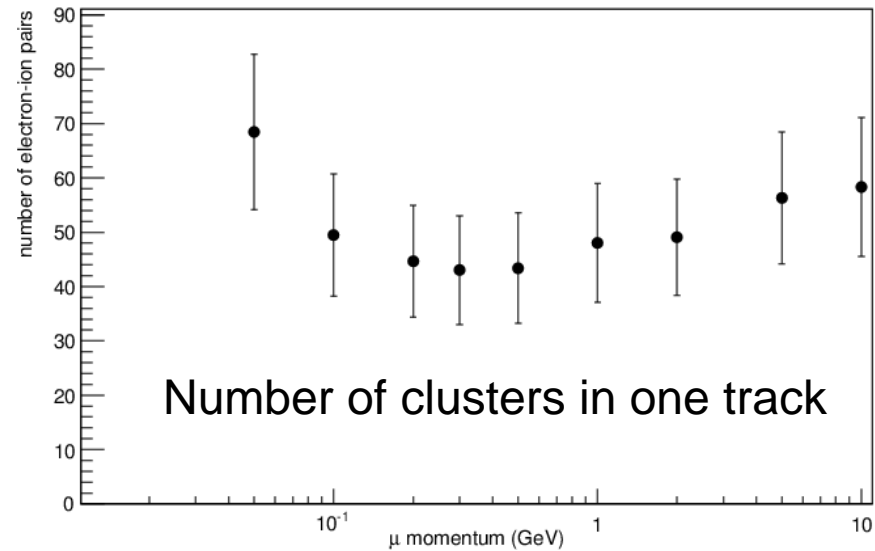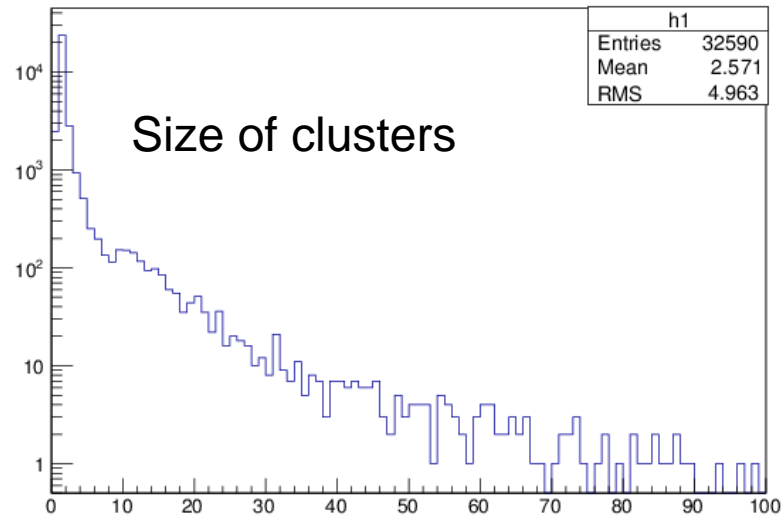
- Histograms generated by Heed will be used for our parameterized simulation.
- The dE/dx curve shows heed is suitable for muon momentum from 50 MeV to 10GeV.

Amplification from Micro Avalanche Model

1. Secondary ionization very close to wire surface.
2. Assumption of ions coming from the surface of anode wire is used in our parameterized algorithm
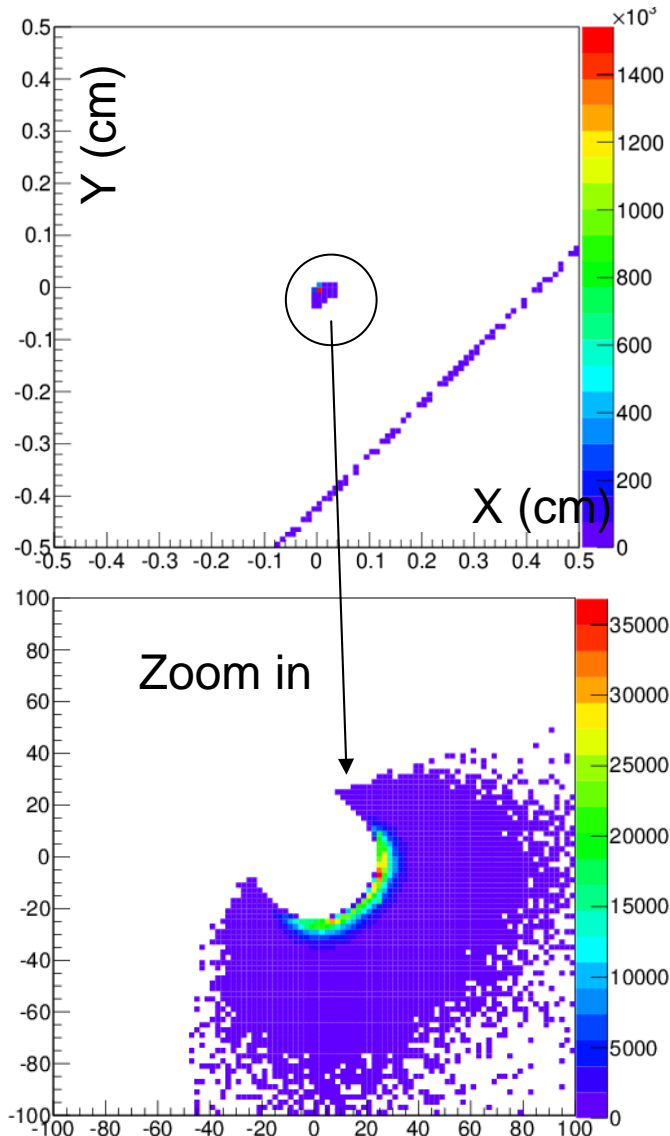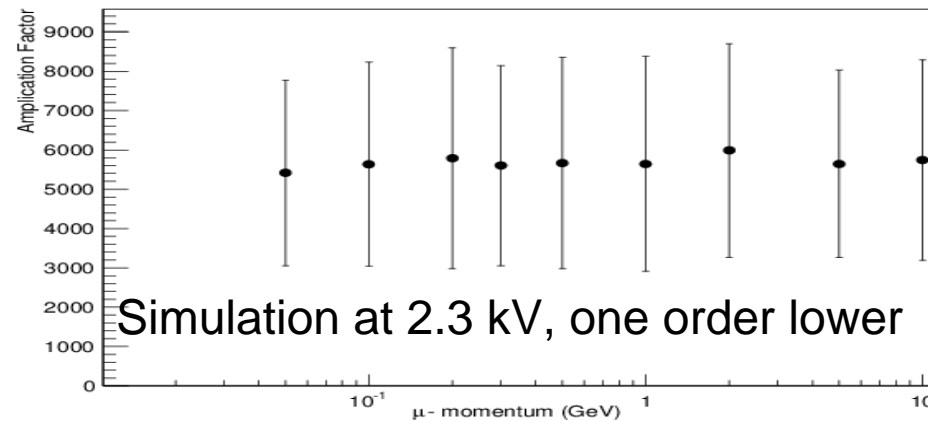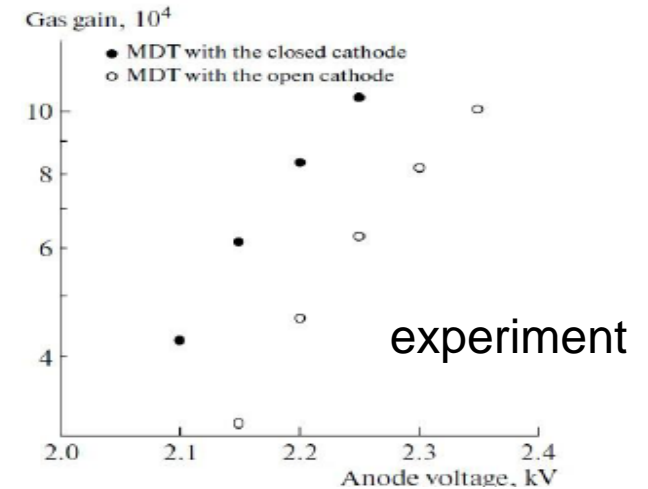
Amplification factor is defined as,

$$A \equiv \frac{N_{collected}}{N_{primary-ionizaion}}$$

experiment

Zoom in

Simulation at 2.3 kV, one order lower

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Anode Signal

1. Amplification factor need calibration.
2. 5.19keV gamma by Fe55 radiative source was referenced as normalization.

Anode readout
Red, electrons induced
Green, ions induced

Anode readout
Red, electrons induced
Green, ions induced
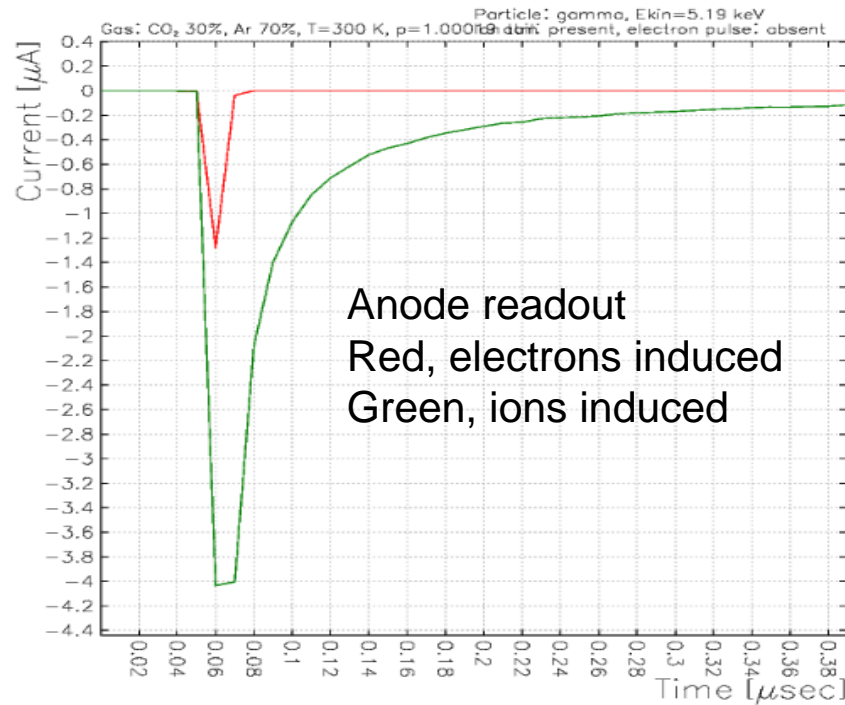
- Raw current signal and signal after convolution with the transfer function.
- The transfer function should be derived from read-out circuit.

Anode VS Strip Readout

Anode wire

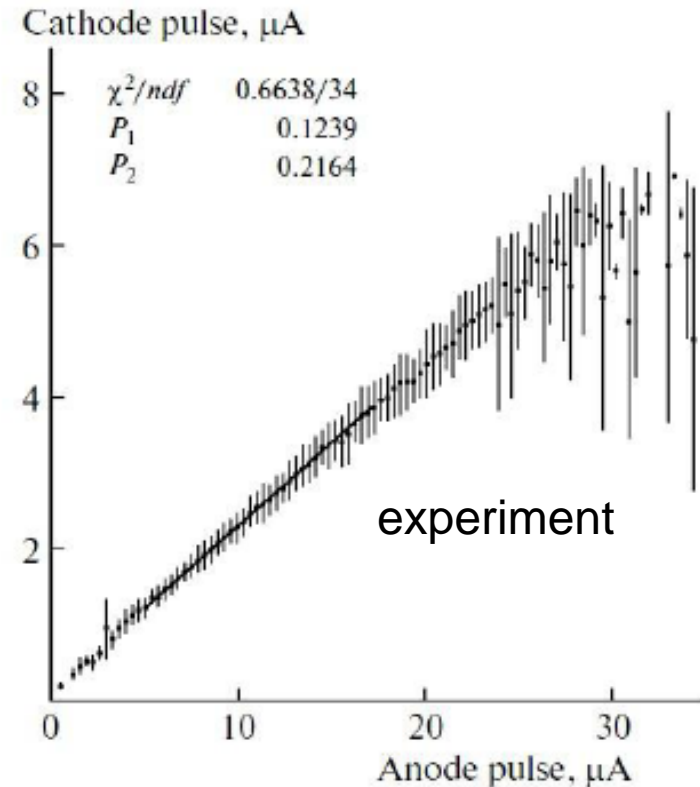Center strip

Cathode pulse, µA
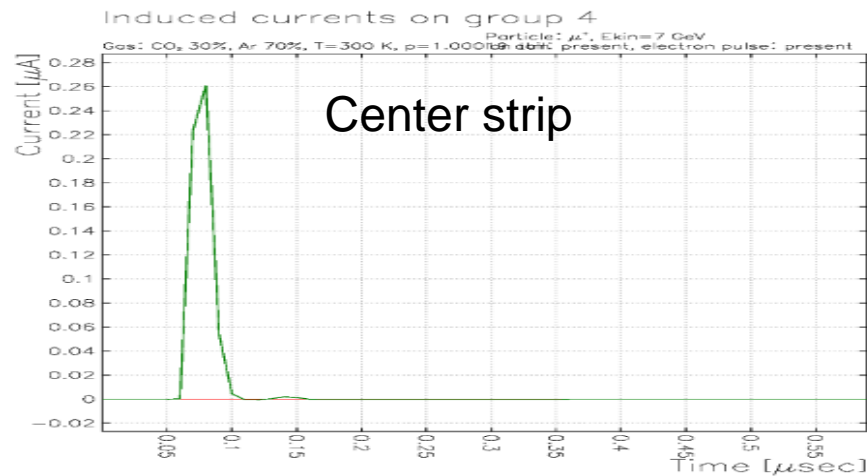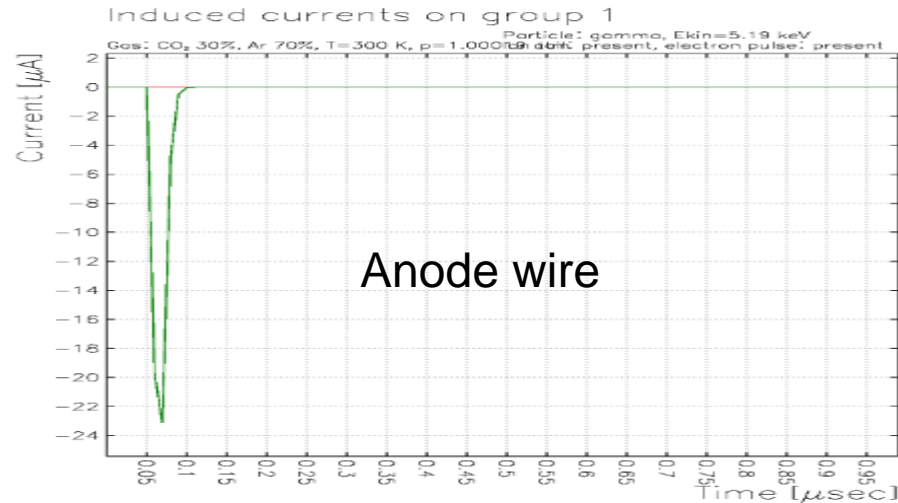
experiment

- Peak current induced on strips is 1.5% of current on anode wire, different from experimental value 21.6%. This point is under check.

Parameterrized Simulation

Approximately ideal current

50ns

0.The muon momentum as the only input.

1.Tubes involved in muon track are digitized.

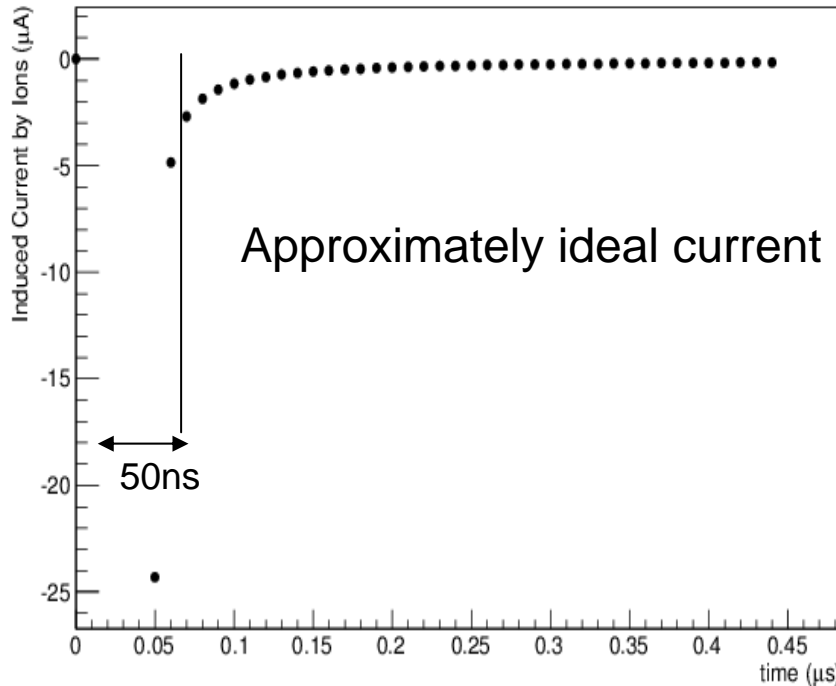2. Cluster sampled by Heed simulation.

3. Avalanche factor is used instead of detailed step-simulation.

4. Ions are assumed moving from wire surface.

5. Electron signal are ignored.

6. The induced current is expressed as,

$$i(t) = -q\mathbf{v}_t \cdot \frac{\partial \mathbf{E}}{\partial V}$$

$$\mathbf{v}_t = \mu(E)\mathbf{E}$$

$$\langle \mu \rangle = 2.88 \text{cm}^2 \text{V}^{-1} \text{s}^{-1}$$

- Parameterized demonstration. Here, we assume the time start from the first cluster, suppose 50 ns for primary electron drift. Later, this time will be sampled according to garfield simulation.

$$\langle N_{pair} \rangle = 200$$

$$\langle A \rangle = 2e4$$

- The difference function can be extracted by de-convolution.

$$i_{\text{detailed}} = i_{ideal} \otimes f(\mu, N, D, A)$$

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Summary and Outlook

- A parameterized digitization algorithm was developed.

- Comparable results can be obtained by set parameters according to experimental measurements.

- Time-based digis simulation and Reconstruction will be developed next.