KOREA UNIVERSITY
NUCLEAR PHYSICS LABORATORY

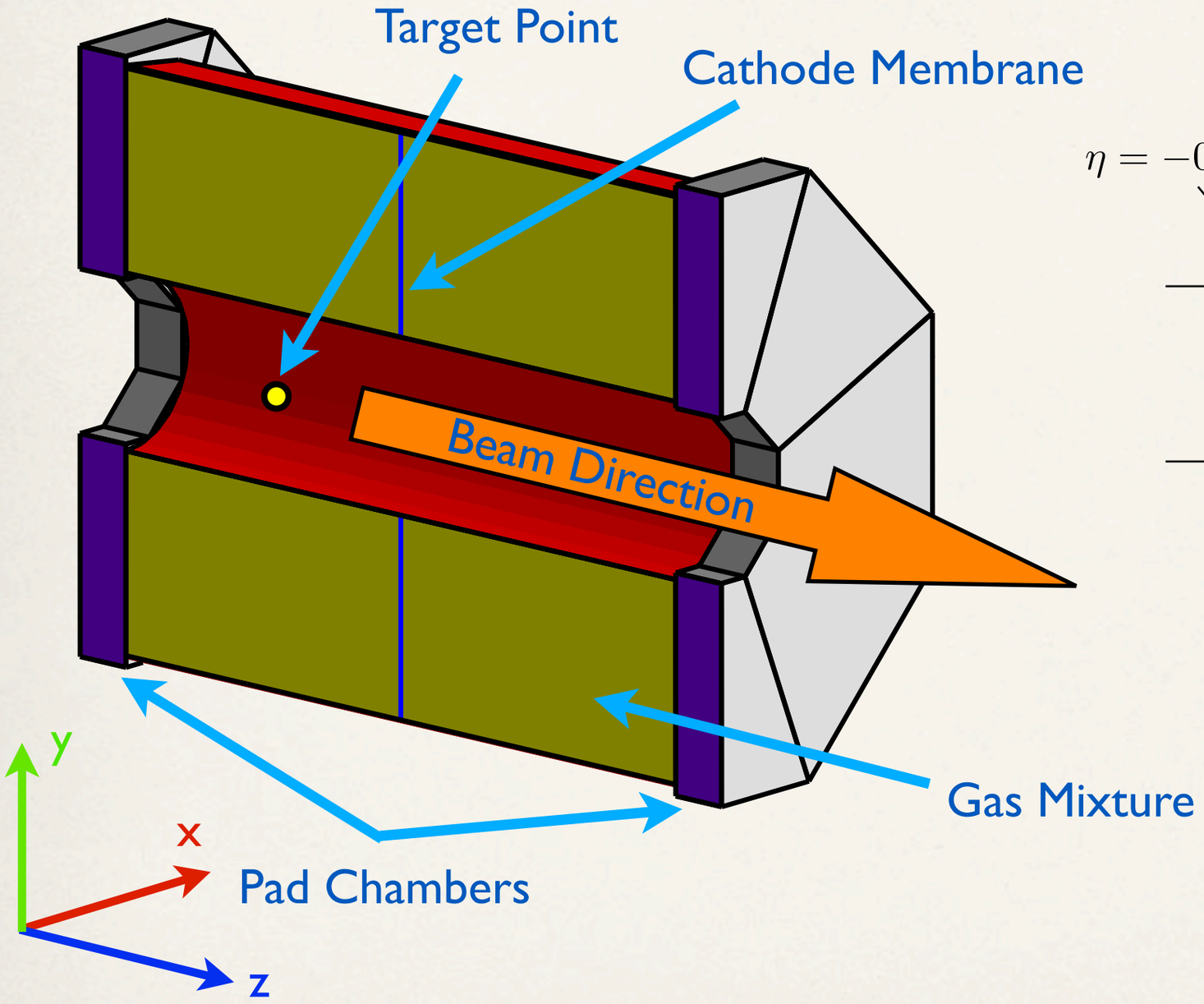
Simulation of TPC

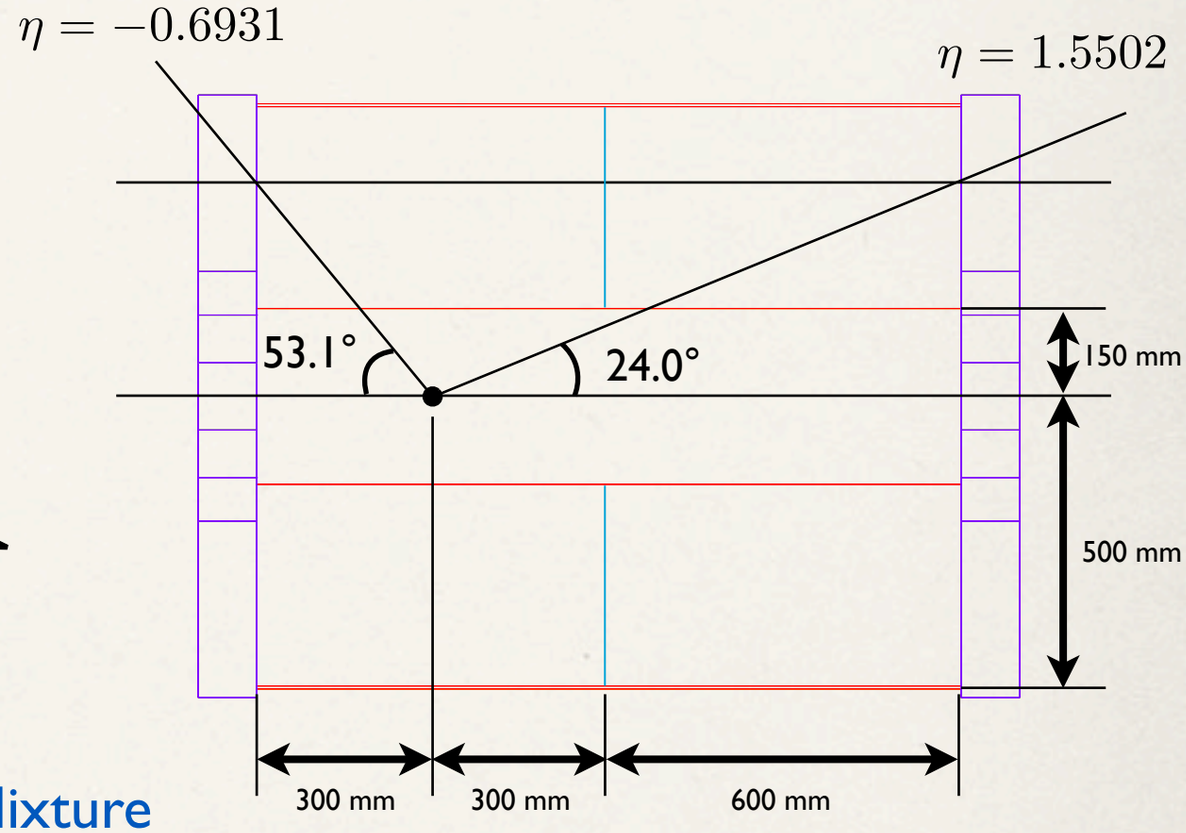
Genie Jhang

Outline

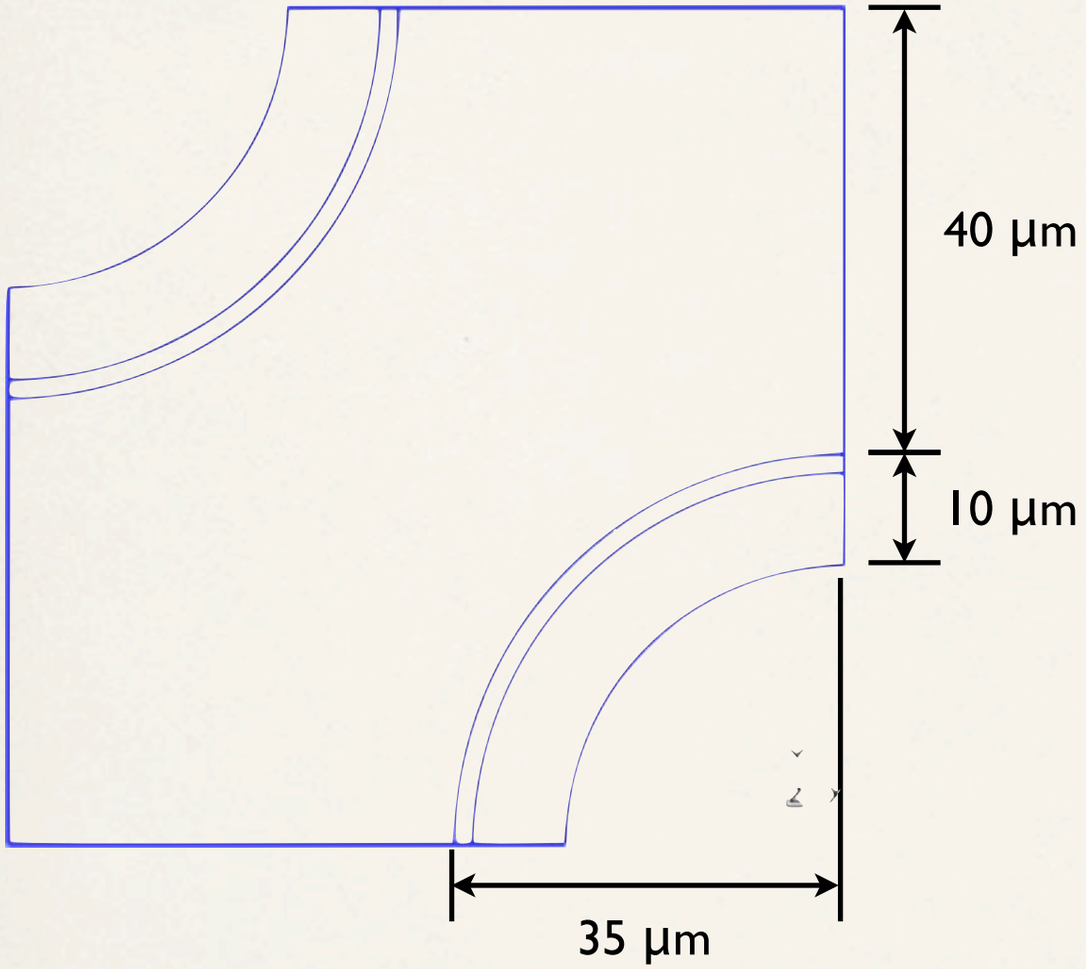
- Introduction
- Design of TPC for LAMPS$_H$
- Simulation results
- Discussion on future study

Time Projection Chamber

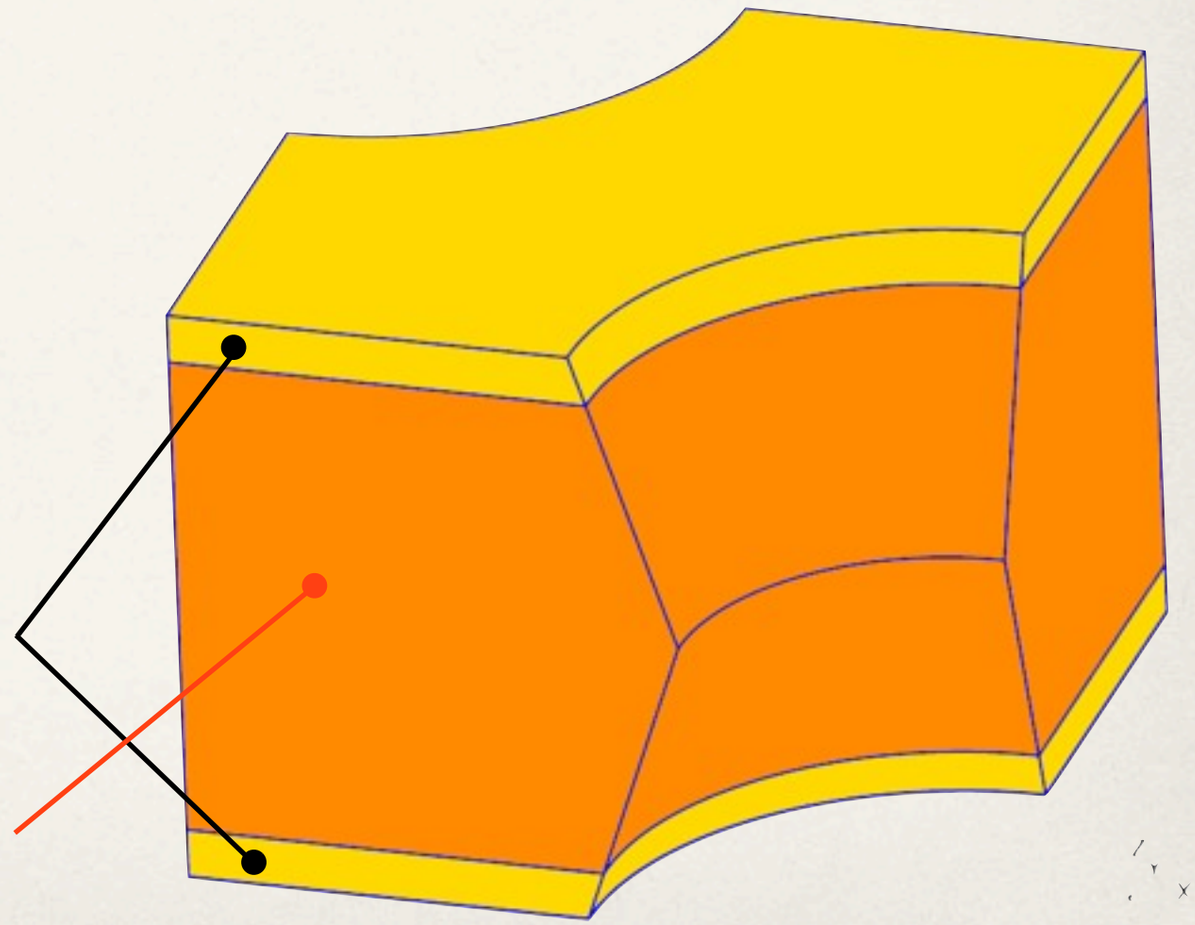




GEM Simulation for TPC



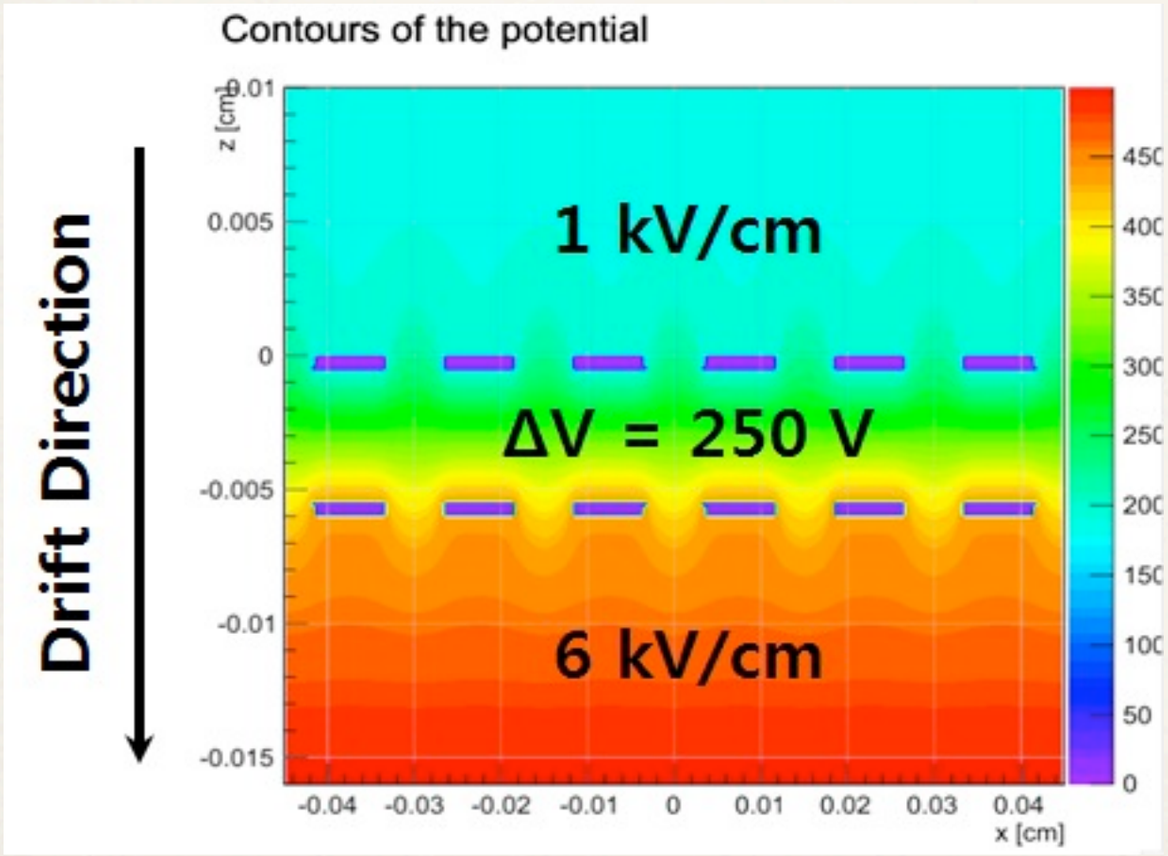
- Repetitive element of GEM foil designed with Gmsh for using finite element method with ELMERFEM

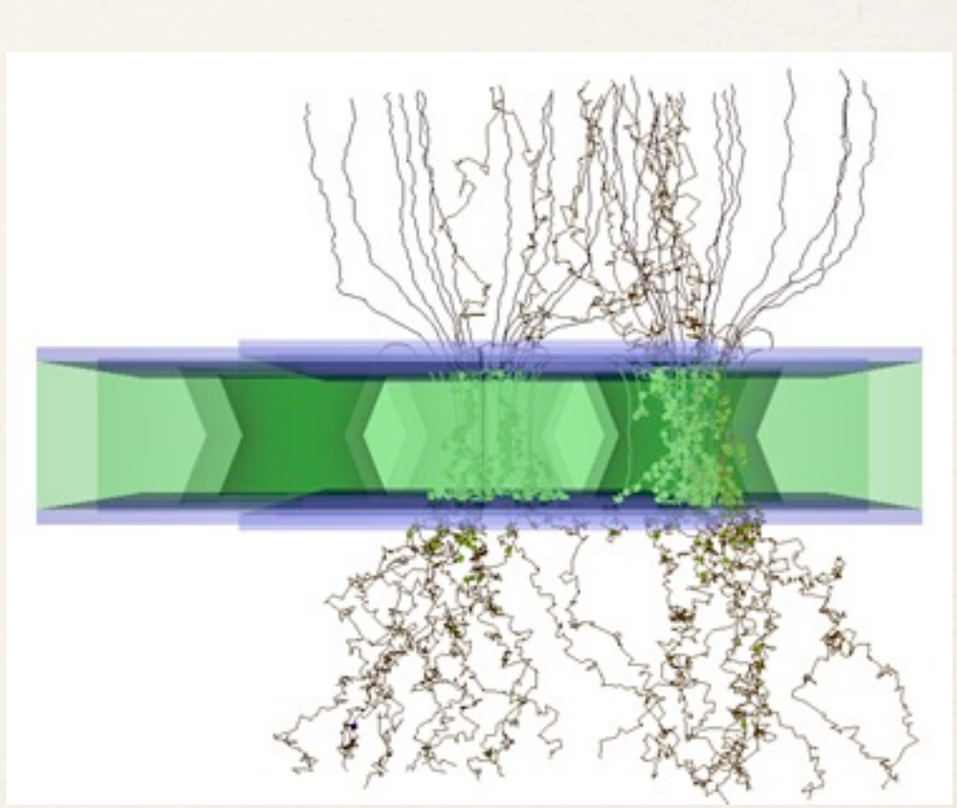


Reference:
ts-dep-dem.web.cern.ch/ts-dep-dem/products/gem/

GEM Simulation for TPC

- Drift electrons inside specific gas mixture and the drift voltage using Garfield++.
- Drift time, drift velocity, gain, dispersion data are obtain for fast TPC simulation.
- Optimized gas mixture and gap voltage should be determined.



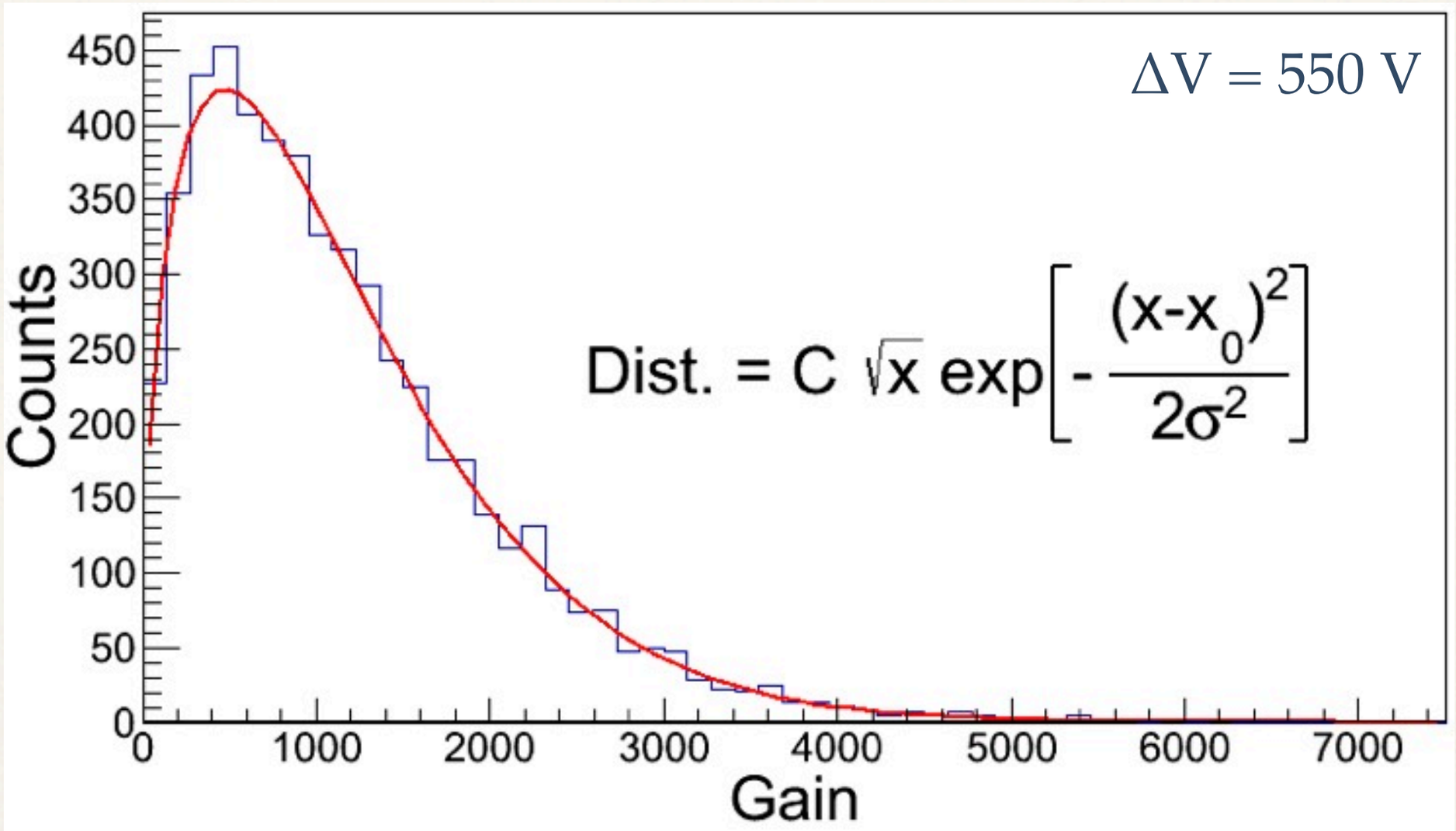


Reference: http://garfieldpp.web.cern.ch/garfieldpp/

GEM Simulation for TPC

Gas mixture: P10

- Amplification data

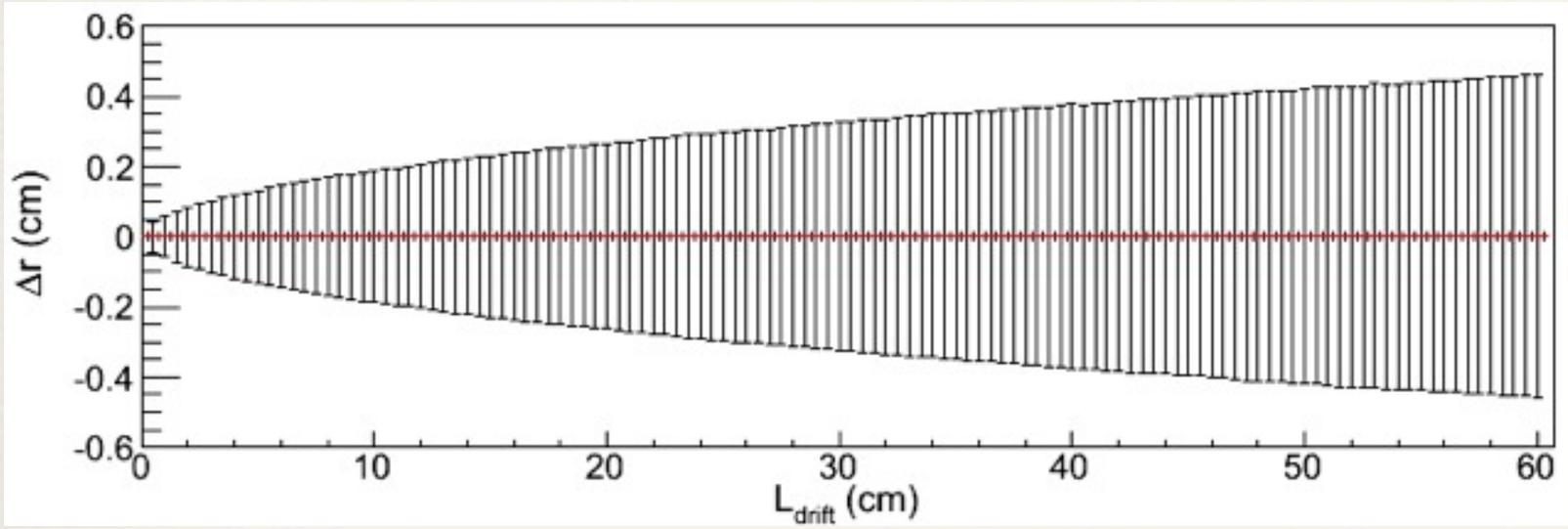


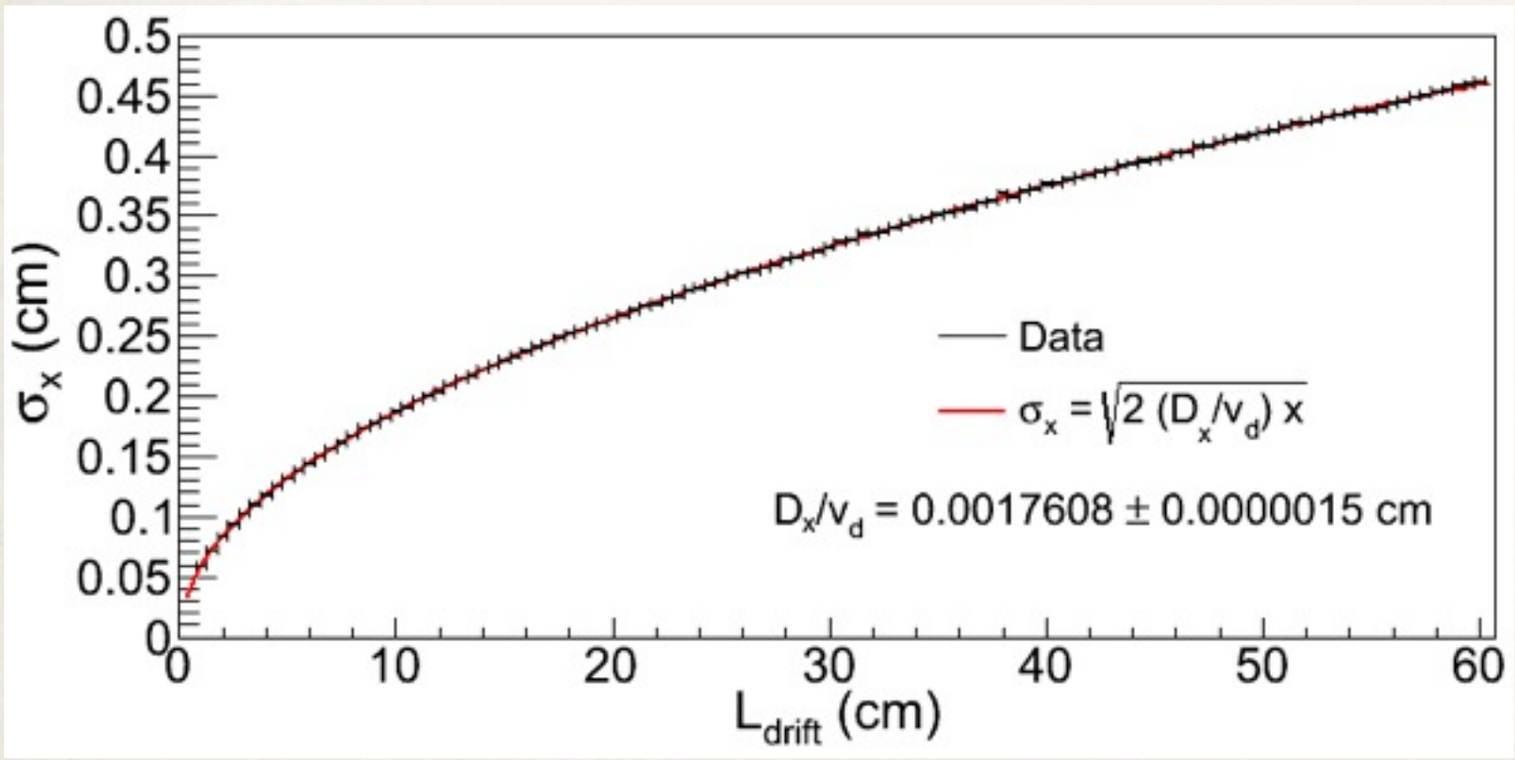
- Normalizing the empirical fit function above, we used it as probability distribution function for amplification

GEM Simulation for TPC

Gas mixture: P10

- Diffusion data



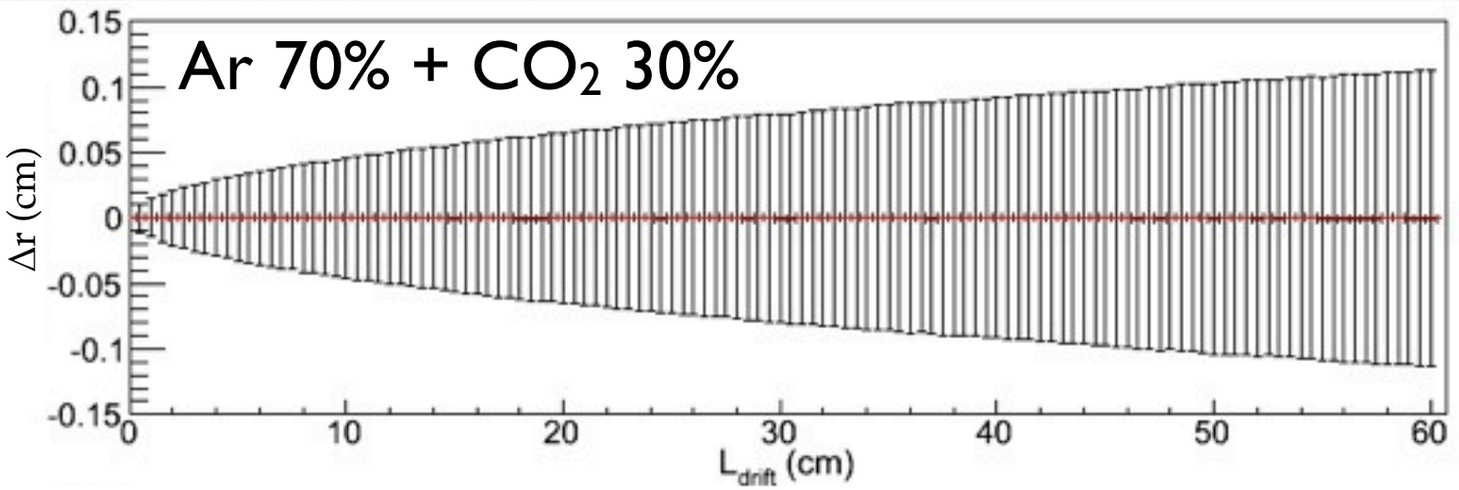


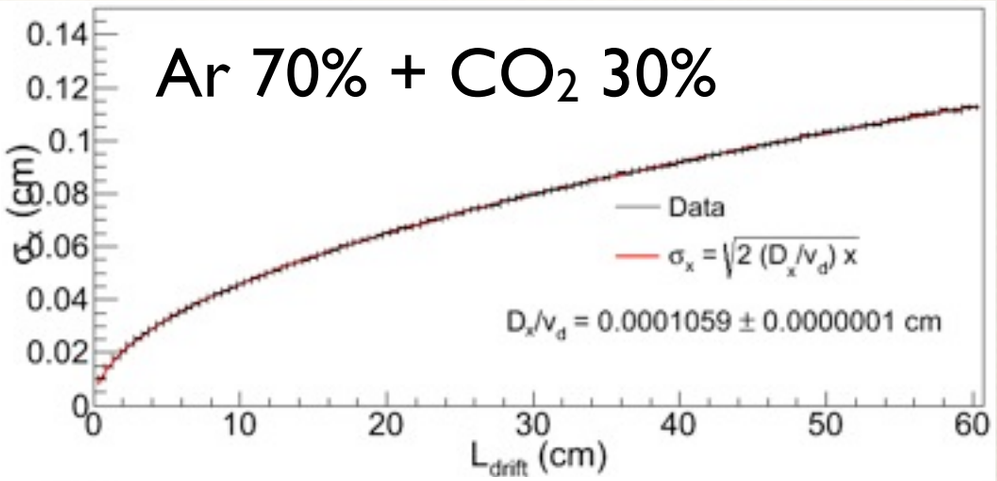
- Obtained from fitting the distribution of electrons after drifting corresponding length.

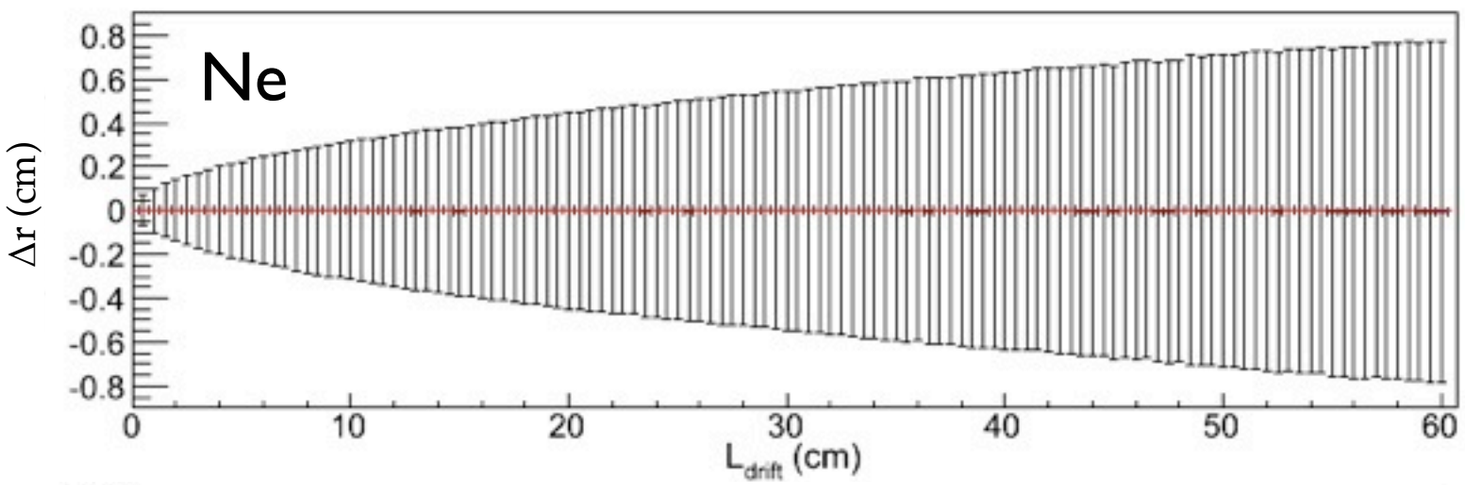
- Used the standard deviation for corresponding drift length

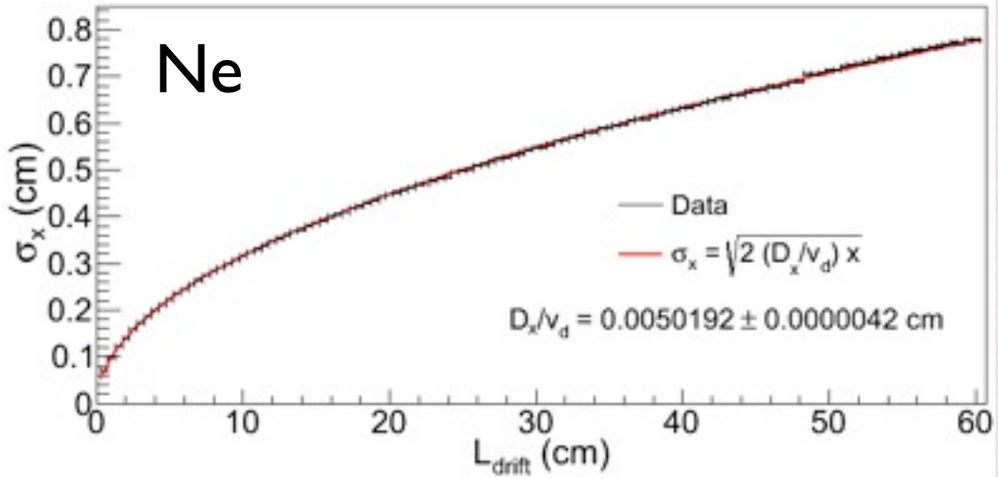
Reference:
William R. Leo,
Techniques for Nuclear and Particle Physics Experiments 2nd Revised Edition, p.133

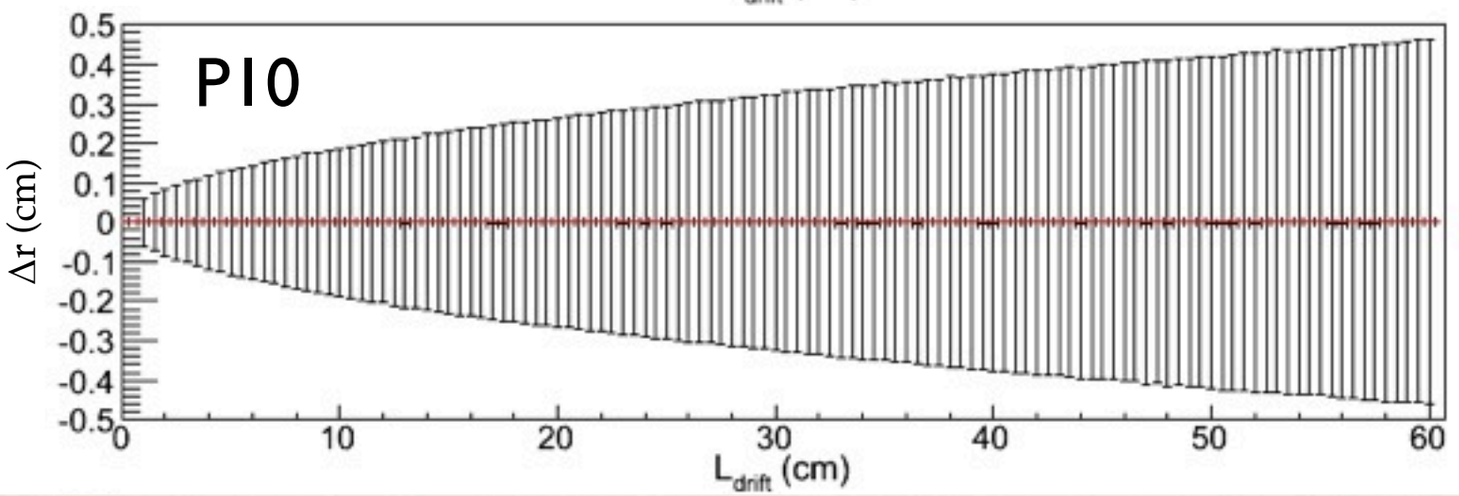
GEM Simulation for TPC

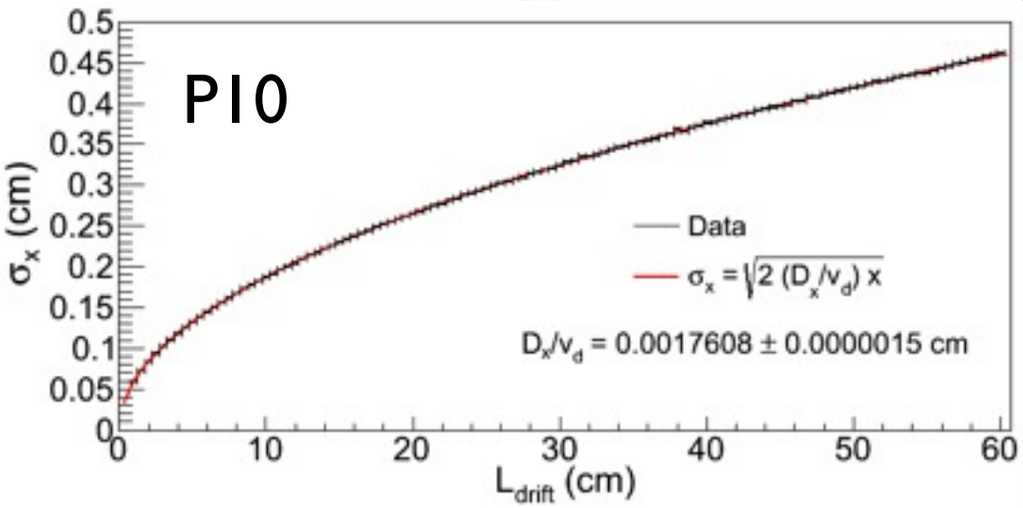






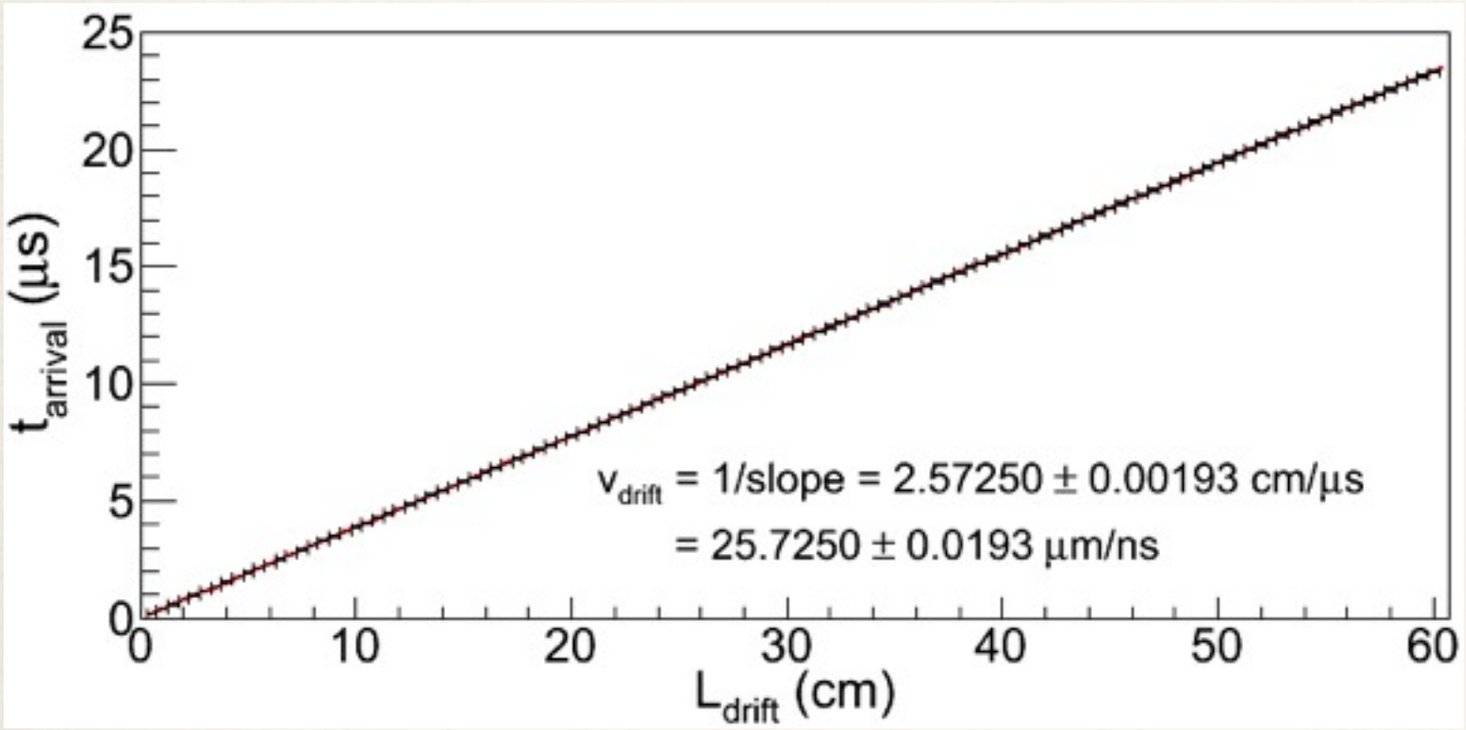




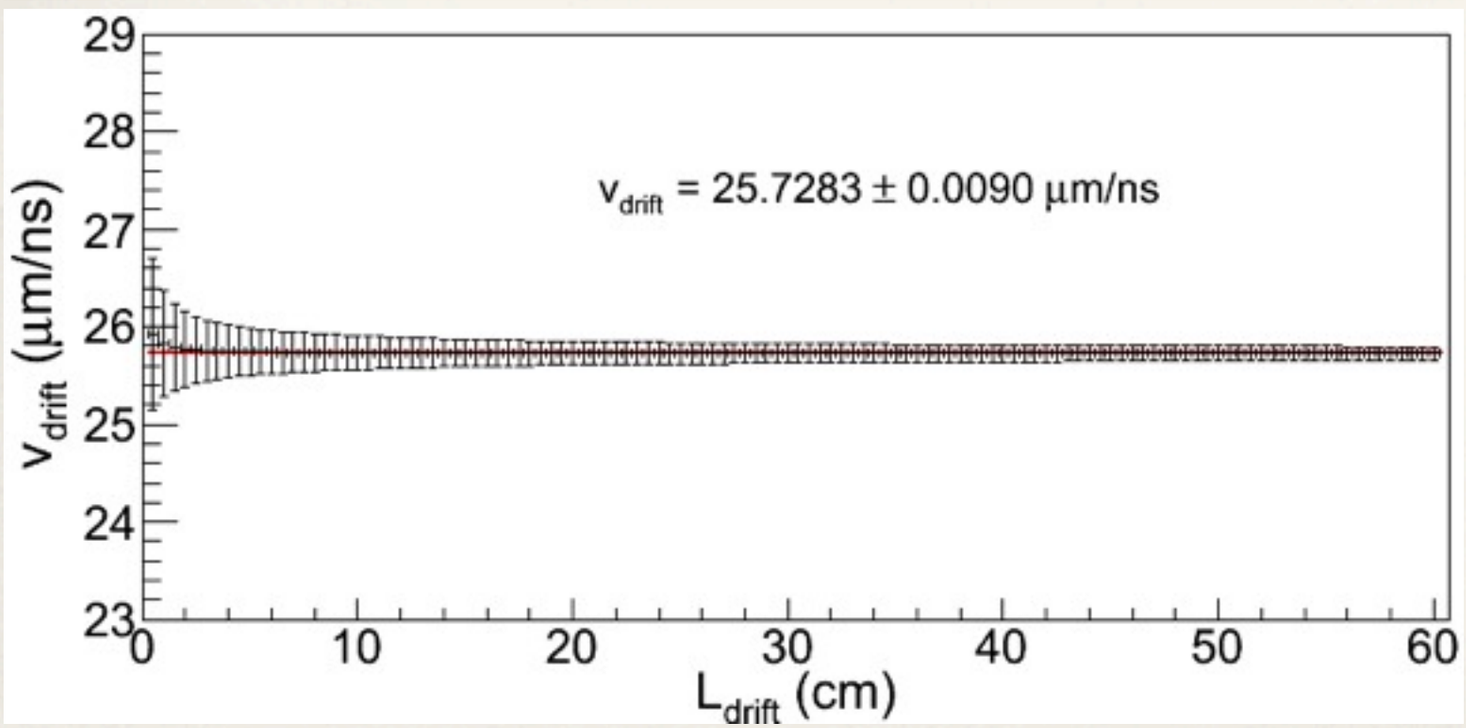


GEM Simulation for TPC

Gas mixture: P10

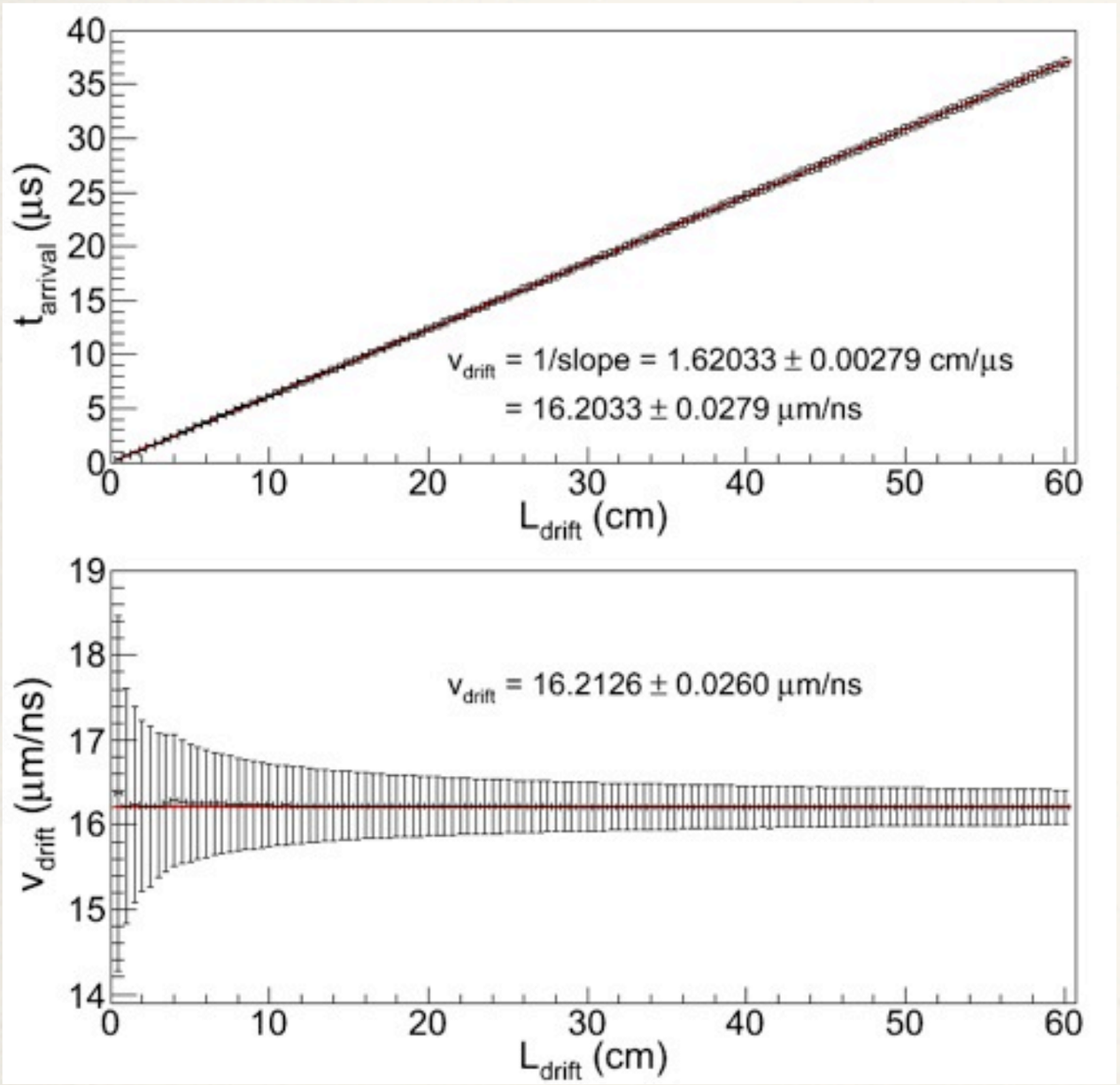


- Obtained from fitting the distribution of electrons after drifting corresponding length.

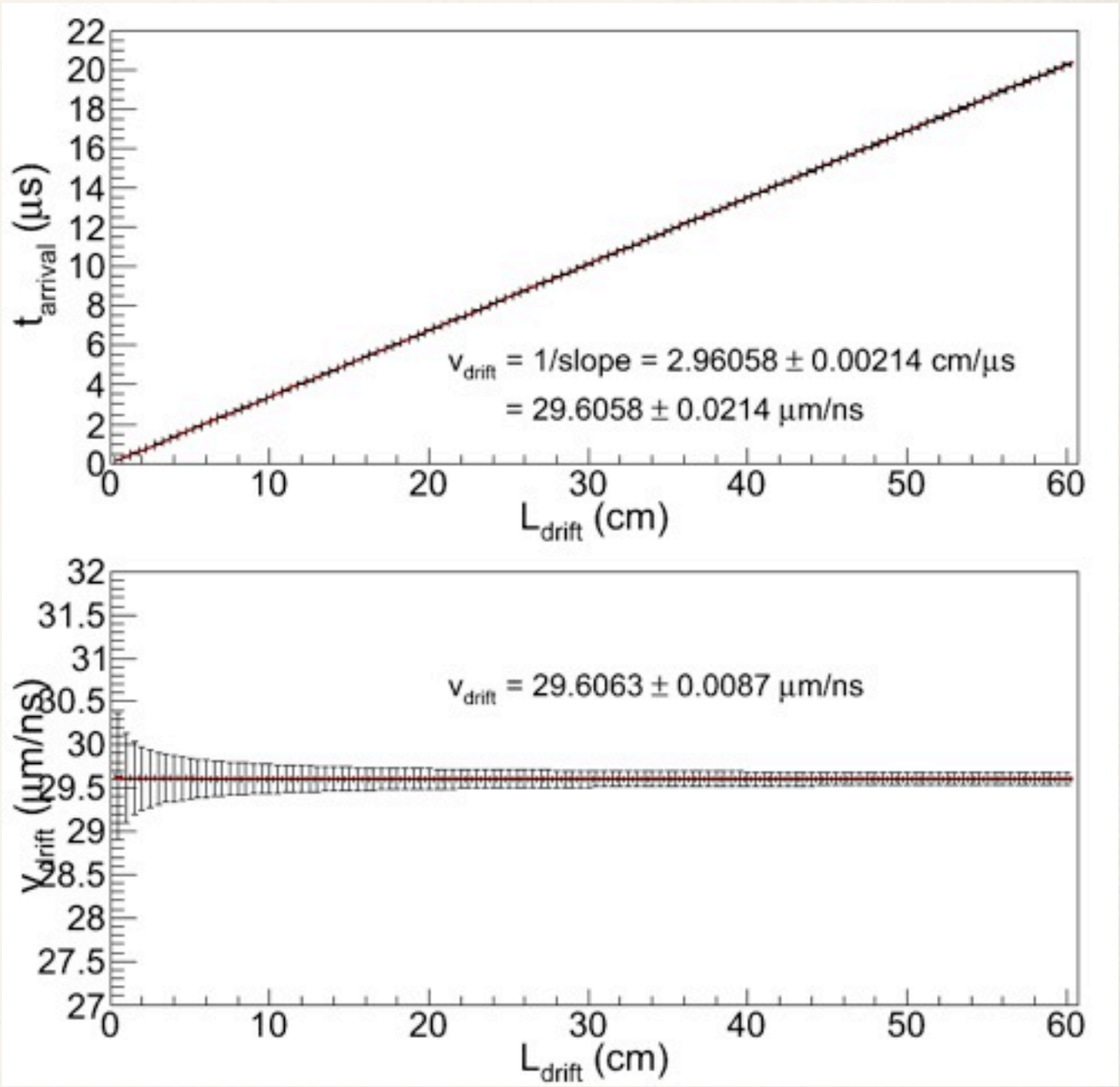


- Drift velocity of one electron is calculated using straight-line distance divided by the drift time.

GEM Simulation for TPC



Ne

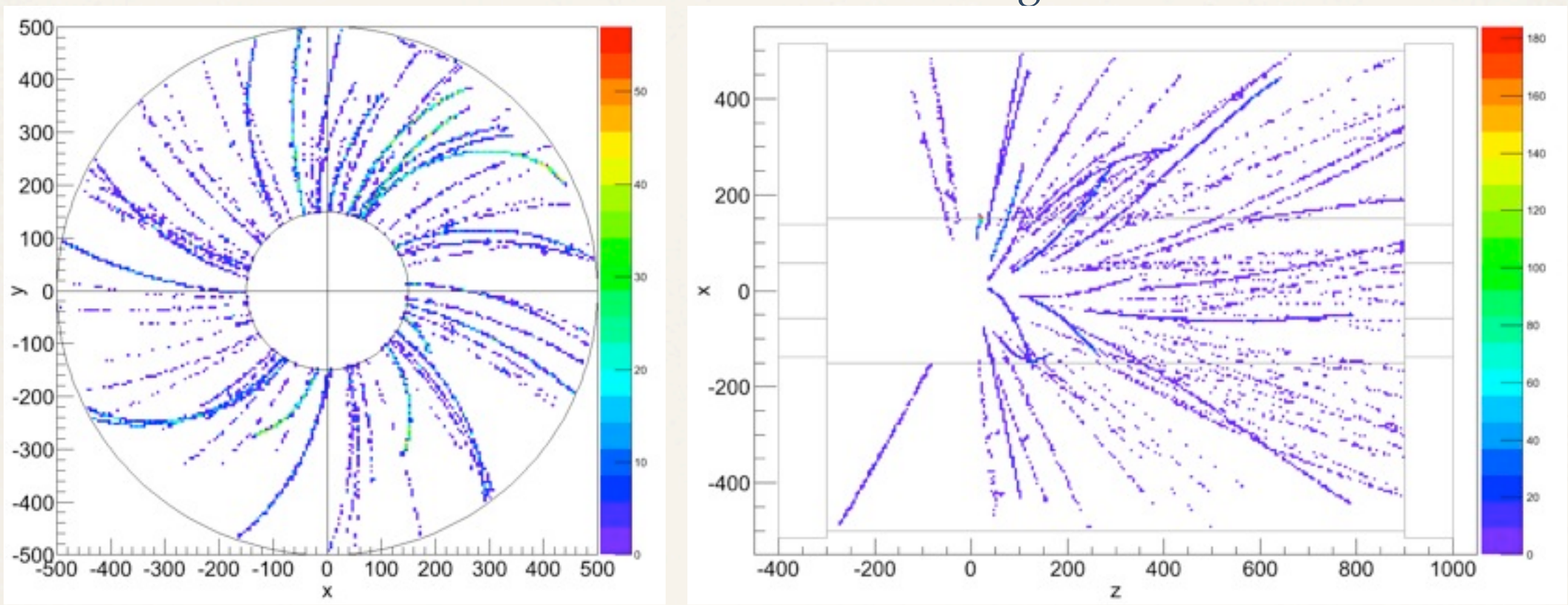


Ar 70% + CO_2 30%

Hit Data of TPC

Transversal View

Longitudinal View



Fixed target IQMD event, 250 MeV/u Au+Au Collision

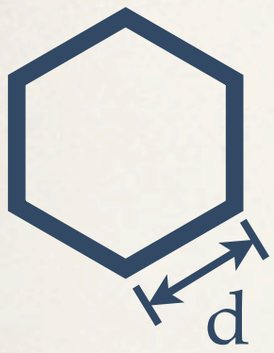
- Hit information by the energy loss of charged particles in the gas volume of TPC. (Right before the digitization process)

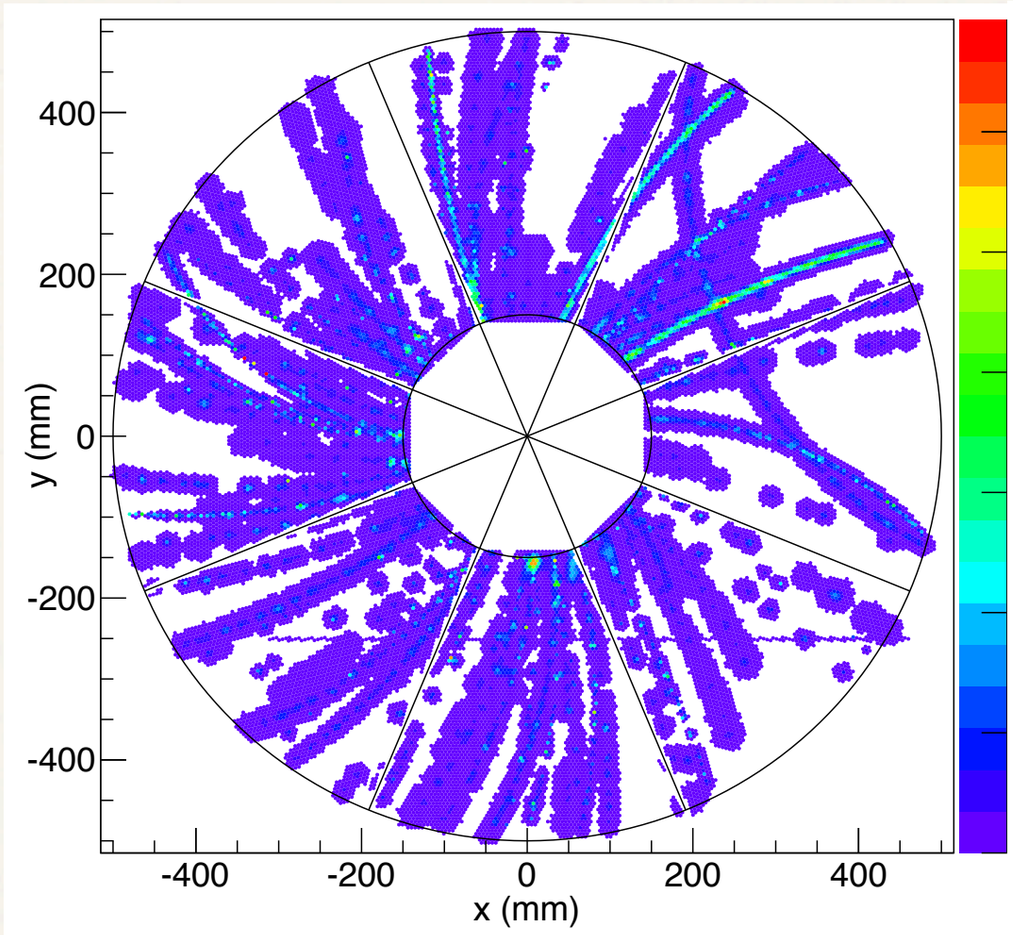
Digitizing Hit Data of TPC

Fixed target IQMD event, 250 MeV/u Au+Au Collision

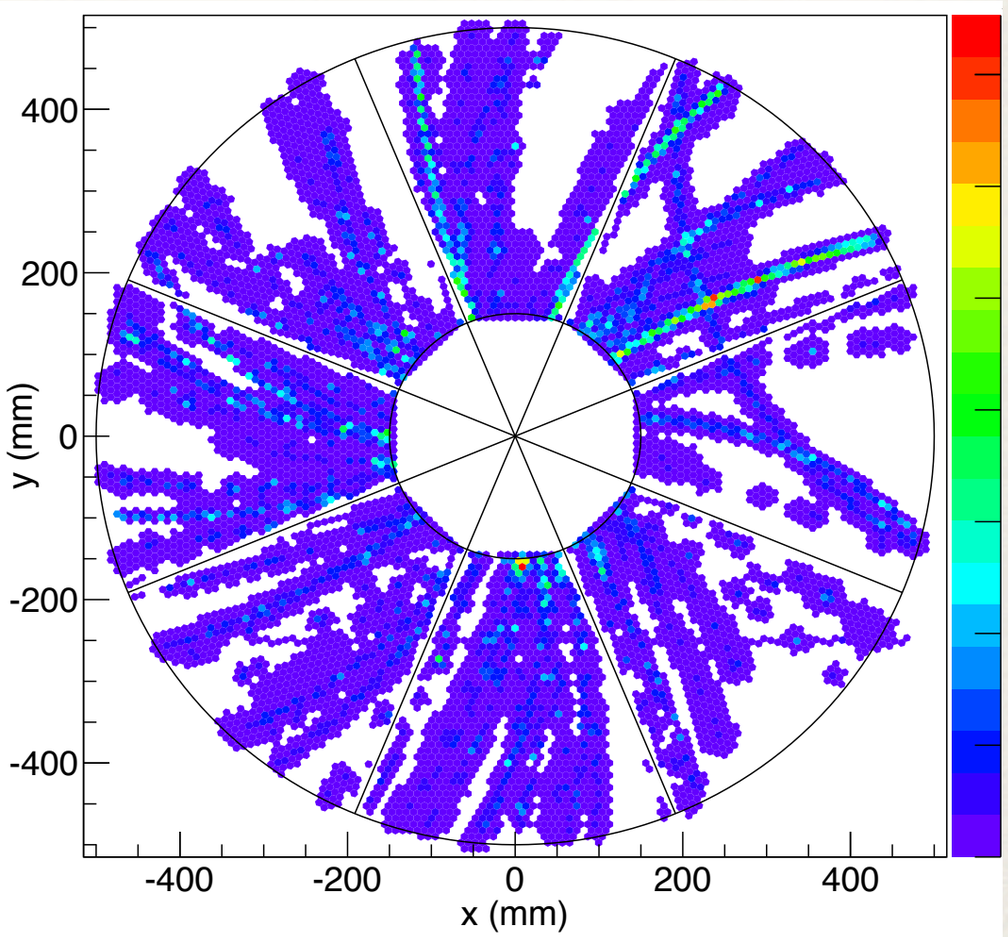
Gas mixture:
P10

One Pad:





d = 2.5 mm # of pads ~90k

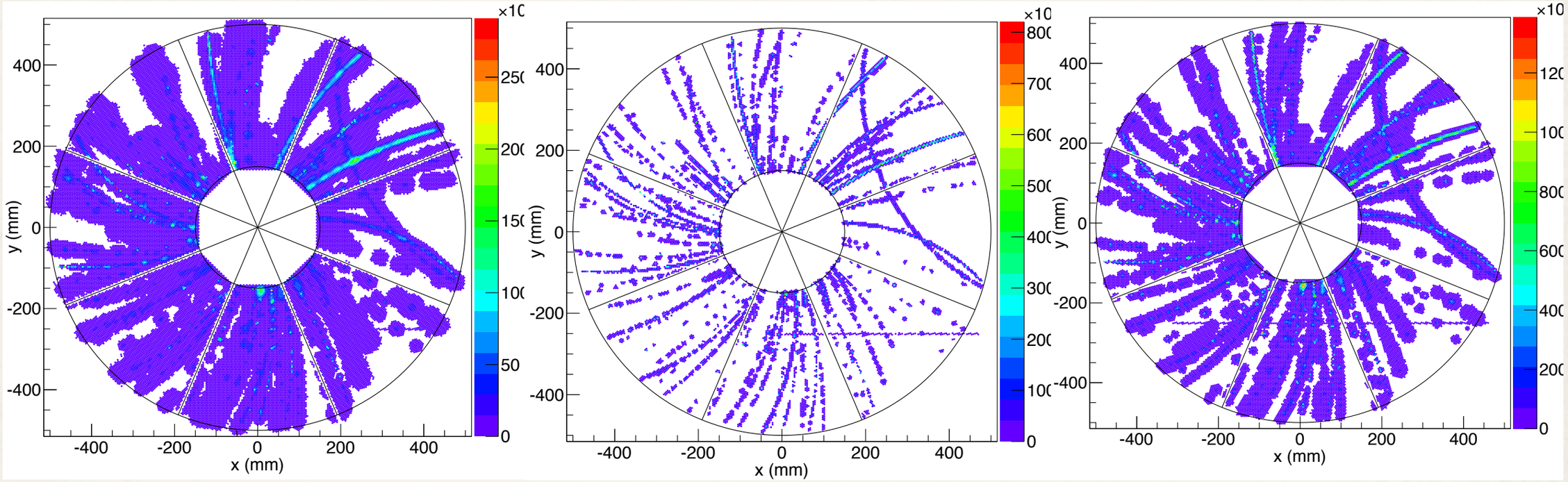


d = 5.0 mm # of pads ~20k

- Plots show the digitized data on pads with different pad size.
- Pad size needs to be optimized.
- Clustering process and track reconstruction process is to be made.

Digitizing Hit Data of TPC

2.5 mm Pad

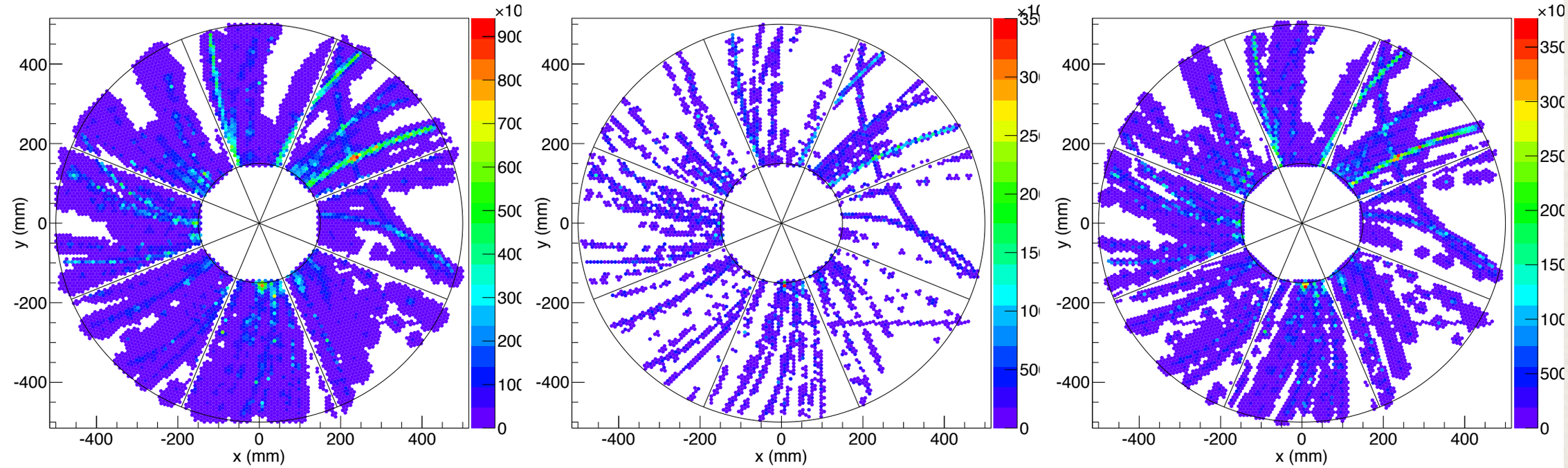


5.0 mm Pad

Ne 100%

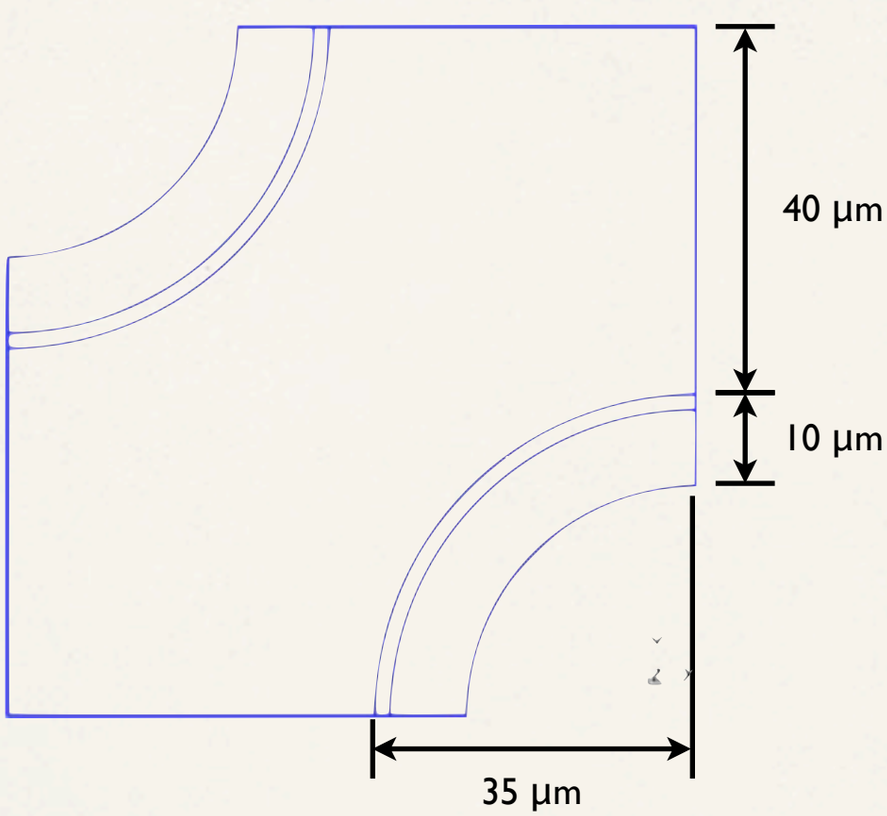
Ar 70% + CO_2 30%

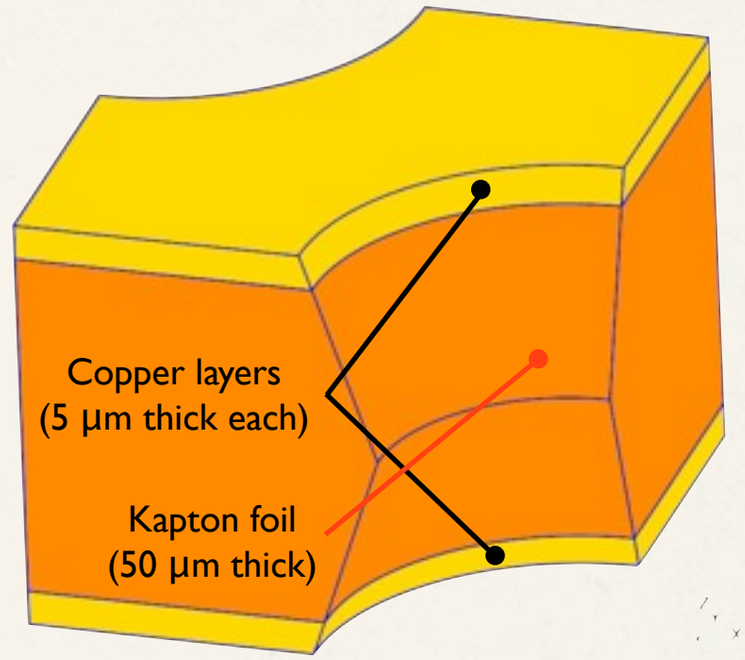
P10



Discussion on Future Study

1. GEM

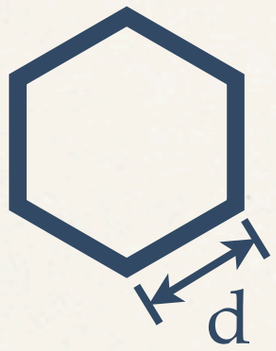




- Hole is not symmetrically distributed with current design. (mistake but not serious)
- Optimization
  - # of GEM foils
  - hole size
  - gap voltage
  - thickness of copper and Kapton foils
  - gas mixture
  - gap distance between GEM foils

Discussion on Future Study

2. Pad size



d	2.5 mm	5.0 mm
# of pads	~90k	~20k

3. Gas Mixture

$E_{drift} = 1\ kV/cm$	v_{drift} (cm/μs)	$\sigma_{r,max}$ (cm)
$Ar : CO_2 = 7 : 3$	2.96	~0.11
Ne 100%	1.62	~0.75
P10 ($Ar : CH_4 = 9 : 1$)	2.57	~0.46

4. Field Gradient

- Both drift and induction space

Simulation Plan

- ALICE Gas Mixture
  - Ne 85.7% + CO_2 9.5% + N_2 4.8%
- PANDA Gas Mixture
  - Ar 90% + CO_2 10%

Discussion on Future Study

5. Things to do

- Digitization bug fix
- Determining the structure of digitized data
- Writing hit clustering code
- Writing a document of each part of code
- Integration of code for better accessibility