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PANDA straw detector simulation with GARFIELD

By: Sedigheh Jowzaee
Supervisor: Professor Jerzy Smyrski

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Outline

- What is GARFIELD?
- Setting input parameters
- Simulation results and comparison with experimental data
- Plans of simulation

Introduction

- GARFIELD
  - A computer program for the detailed simulation of two- and three-dimensional drift chambers.
- Garfield input is subdivided in sections:
  - *CELL*
  - *FIELD*
  - *MAGNETIC*
  - *GAS*
  - *OPTIMISE*
  - *DRIFT*
  - *SIGNAL*

Cell section

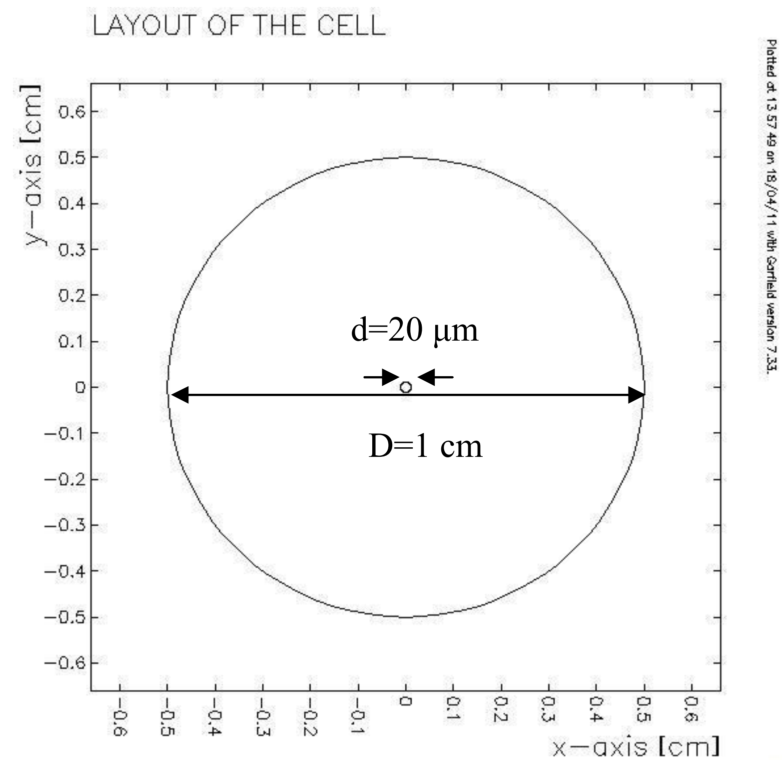
- Detector geometry
- Tube
  - Radius 0.5 cm
  - Voltage 0 V
- Wire
  - Radius 0.001 cm
  - Voltage up to 2000 V
  - Position (0,0,0)

$-0.55 < x < 0.55$

$-0.55 < y < 0.55$

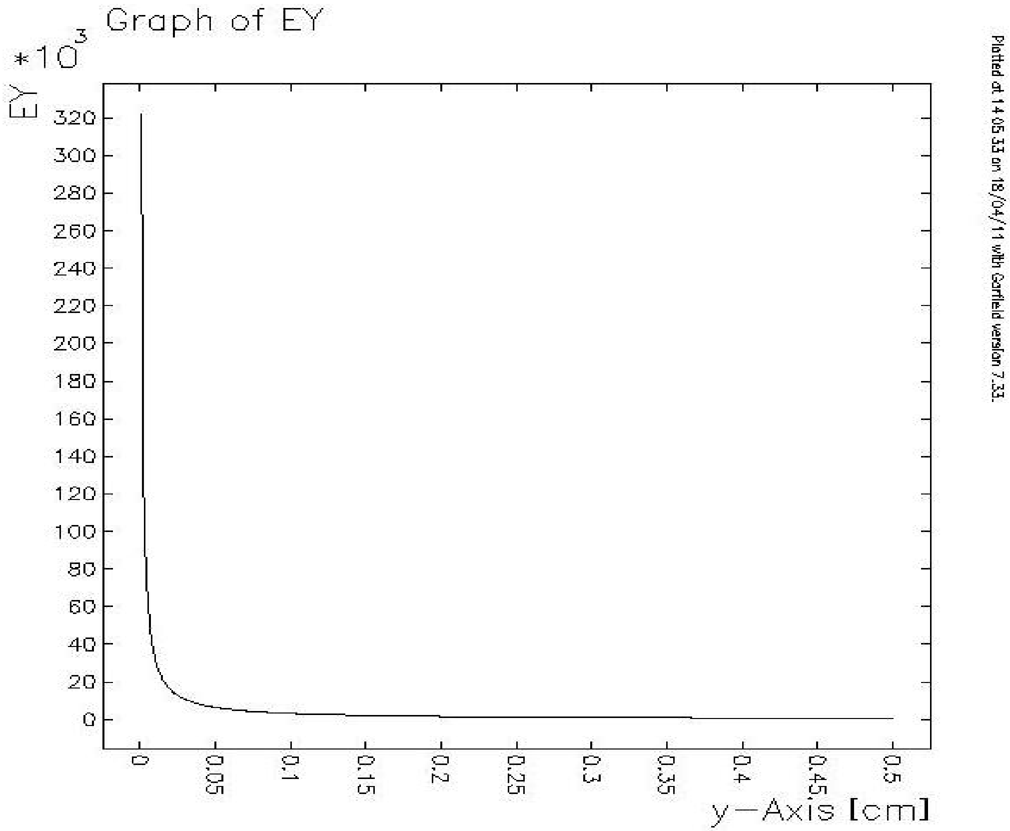
$-70 < z < 70$

$0 < V < 2000$



Field and magnetic section

- Area
- Components B_x, B_y, B_z



600 <E< 320000 V/cm

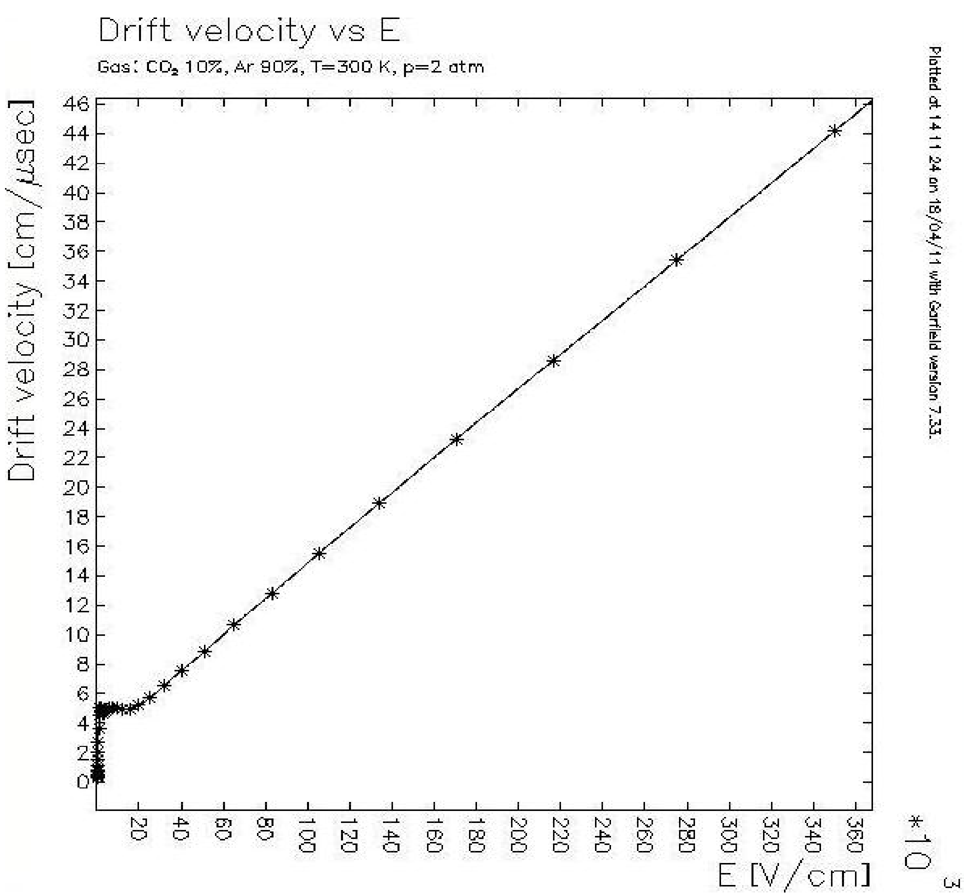
Gas section

- Make a gas file with MAGBOLTZ
  - 90% Ar, 10% CO_2
  - Temperature 300 K
  - Pressure 2 atm
- Importance of different parameters:
  - Electric-field-range
  - The number of points with N-E
  - The number of collisions in MONTE-CARLO integration

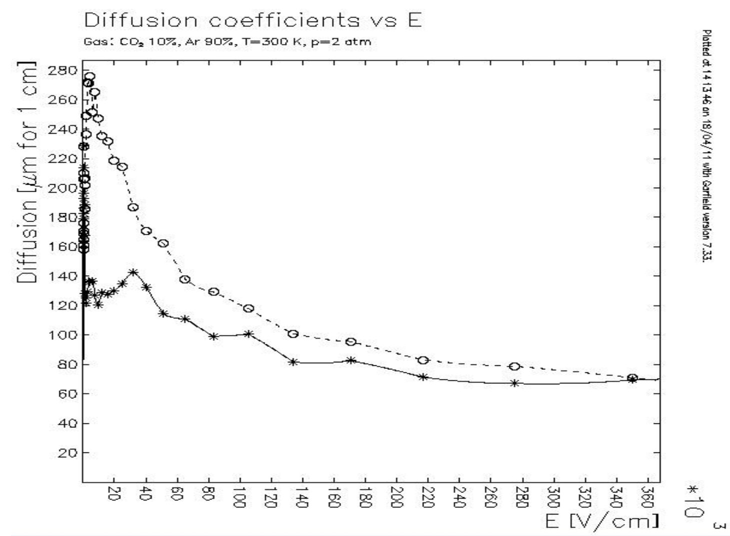
Gas file

- Plot-Gas
  - Drift velocity
  - Lorentz angel
  - Longitudinal diffusion
  - Transverse diffusion
  - Townsend coefficient
  - Attachment coefficient
  - Excitation rates
  - Ionization rates

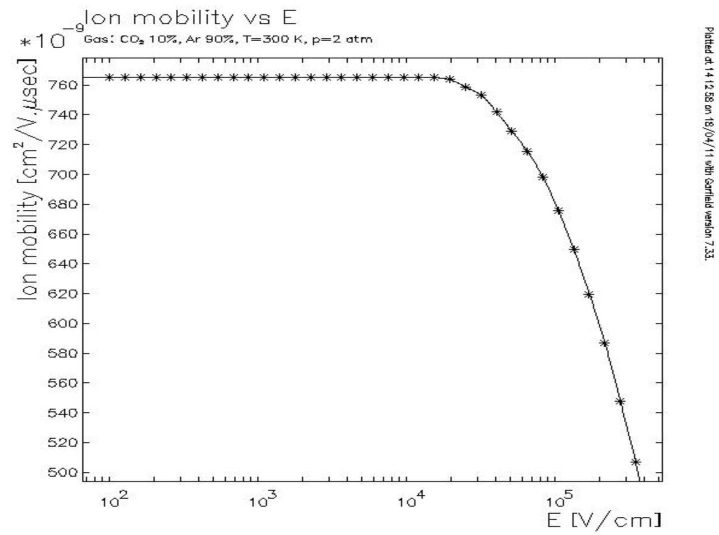
Plot-gas



Drift velocity vs E
Gas: CO2 10%, Ar 90%, T=300 K, p=2 atm
Drift velocity [cm/μsec]
E [V/cm]
*10^3
Plotted at 14.11.24 on 18/04/11 with Garfield version 7.33.

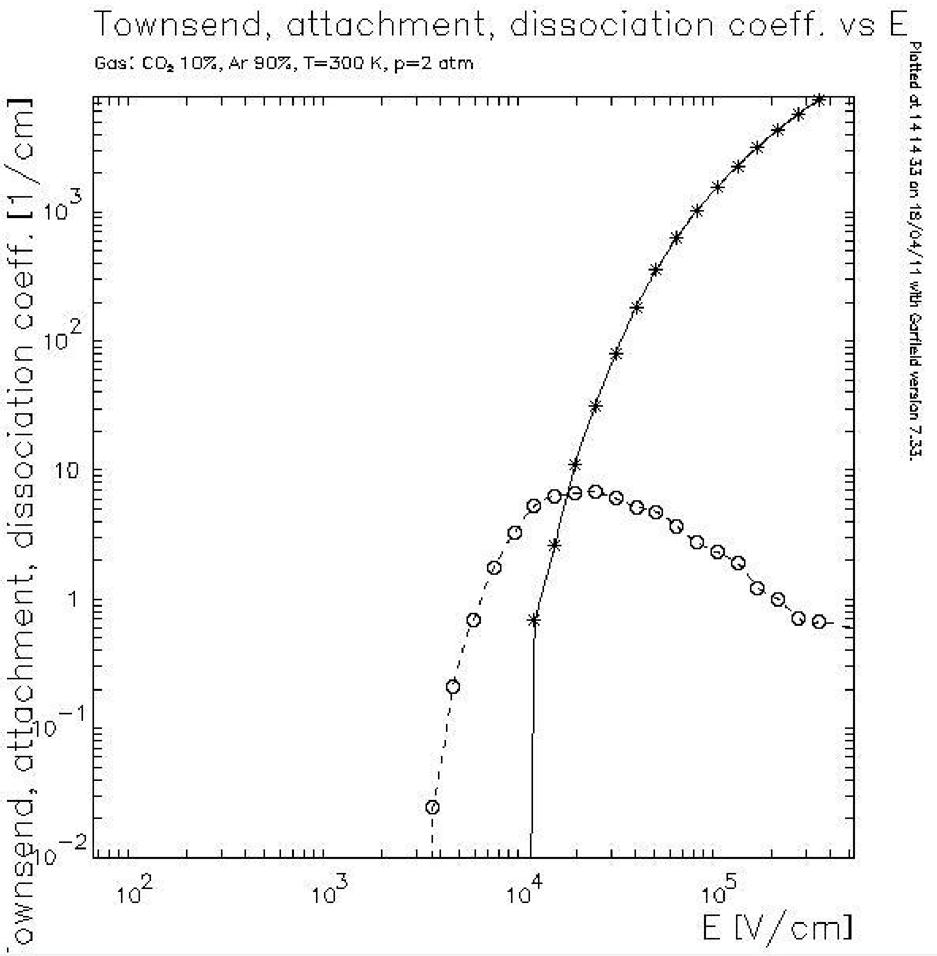


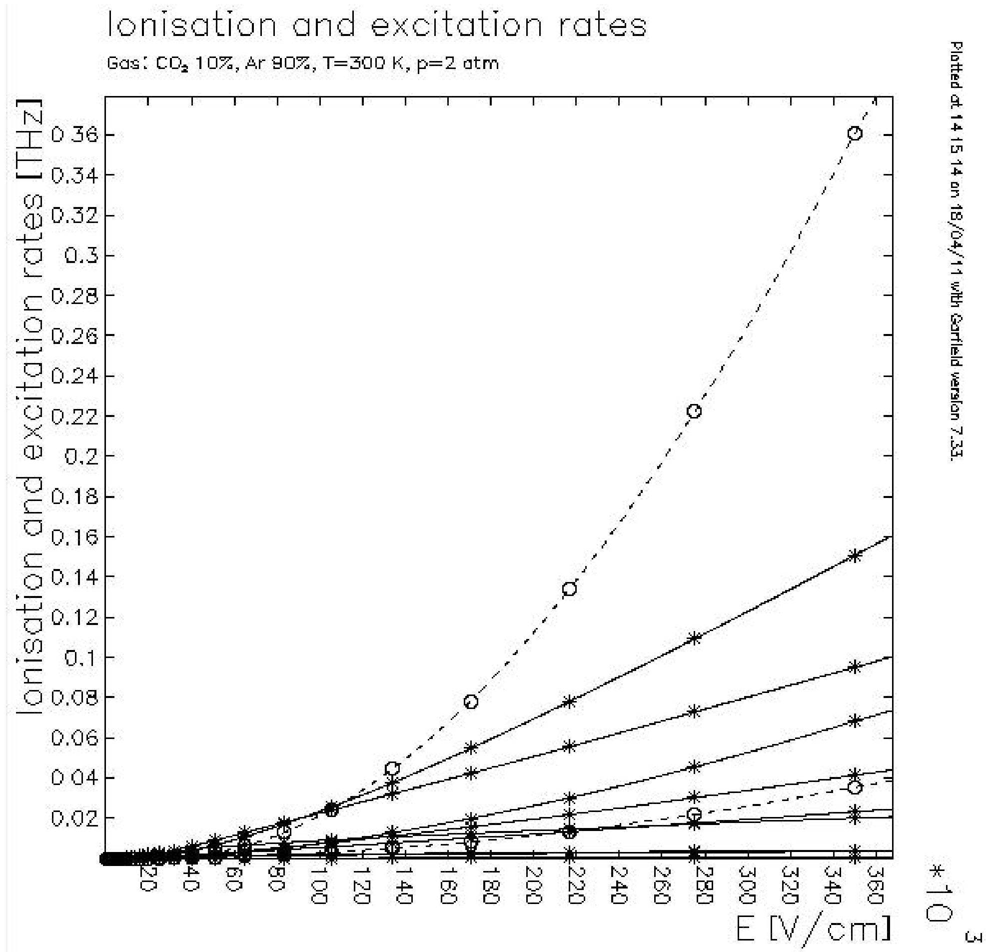
Diffusion coefficients vs E
Gas: CO2 10%, Ar 90%, T=300 K, p=2 atm
Diffusion [μm for 1 cm]
E [V/cm]
*10^3



Ion mobility vs E
Gas: CO2 10%, Ar 90%, T=300 K, p=2 atm
*10^-9
Ion mobility [cm^2/V.μsec]
E [V/cm]

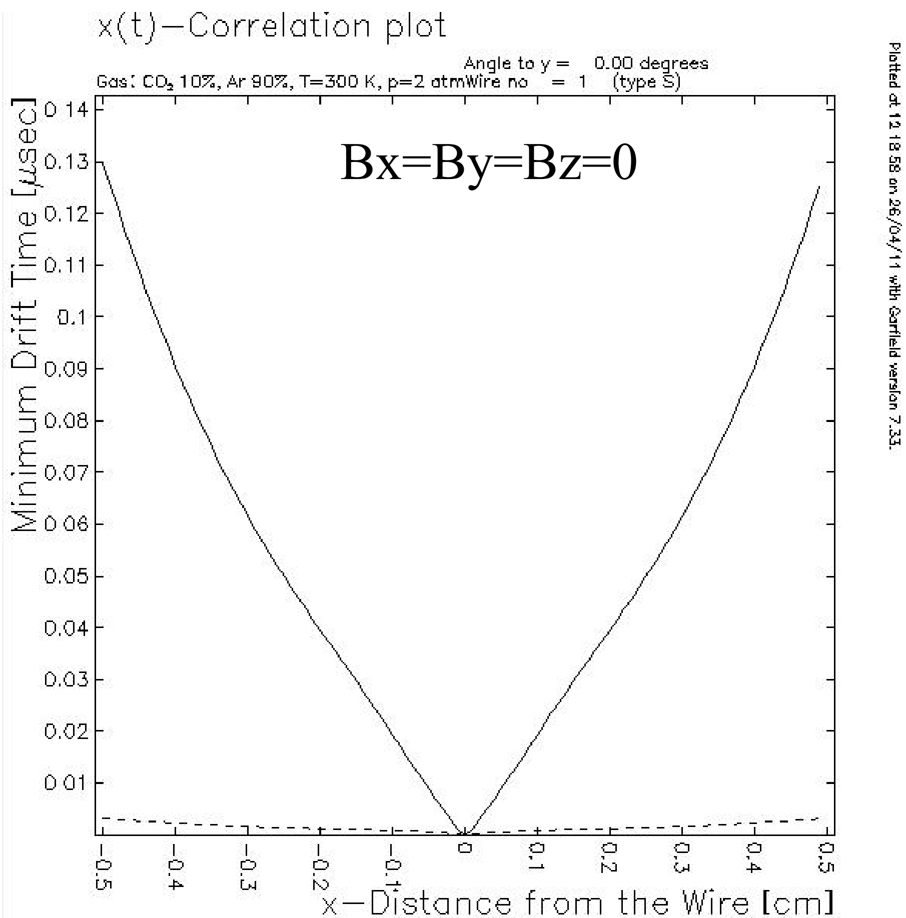
Plot-gas

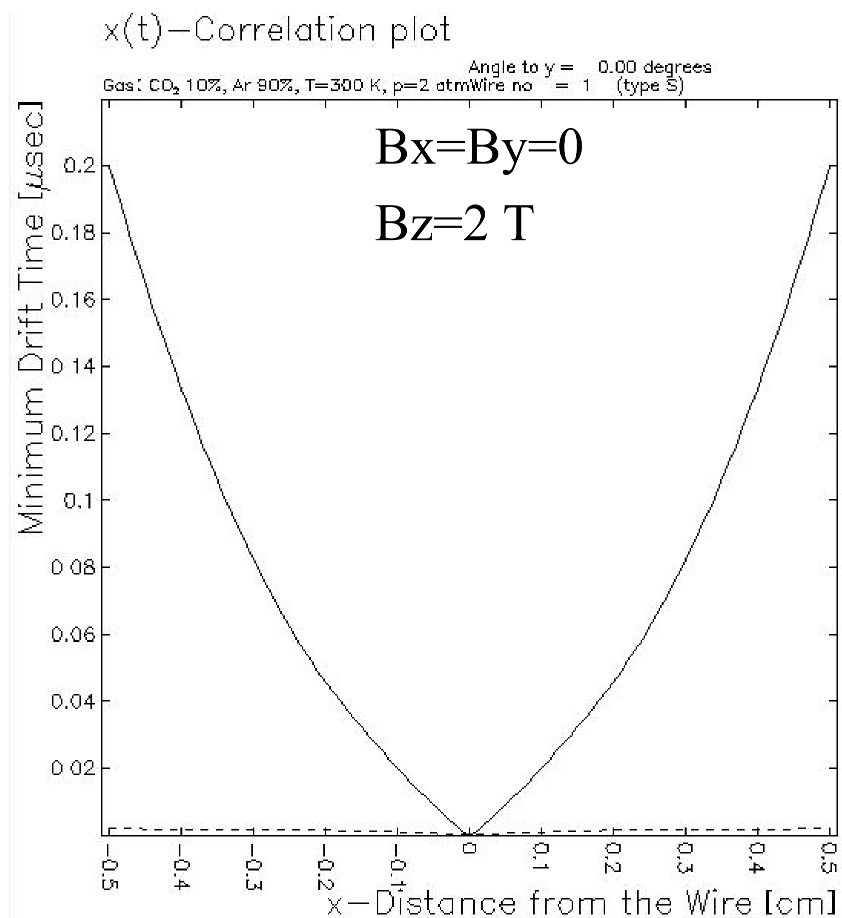

Townsend, attachment, dissociation coeff. vs E
Gas: CO_2 10%, Ar 90%, T=300 K, p=2 atm
Townsend, attachment, dissociation coeff. [1/cm]
E [V/cm]
Plotted at 14:14:33 on 18/04/11 with Garfield version 7.33.


Ionisation and excitation rates
Gas: CO_2 10%, Ar 90%, T=300 K, p=2 atm
Ionisation and excitation rates [THz]
E [V/cm]
*10 3
Plotted at 14:15:14 on 18/04/11 with Garfield version 7.33.

Drift section

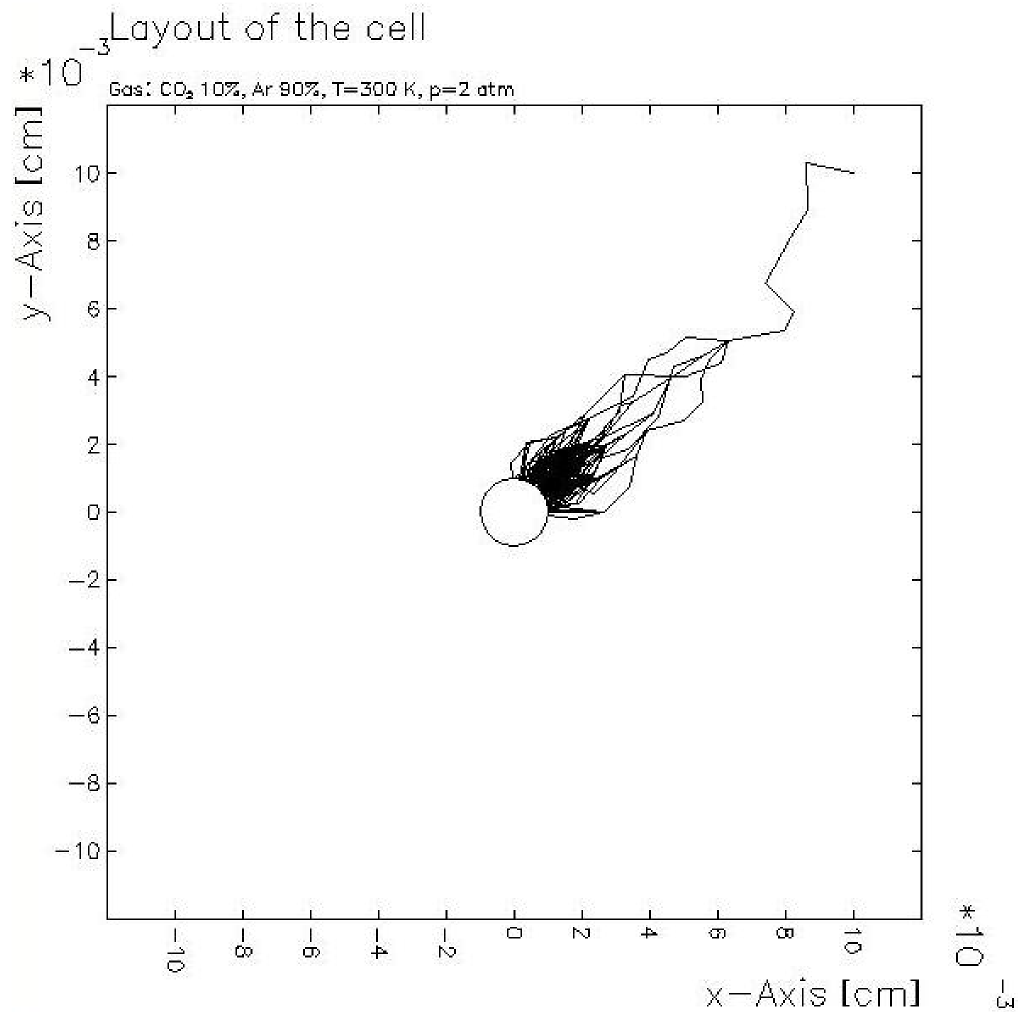
- x-t relation





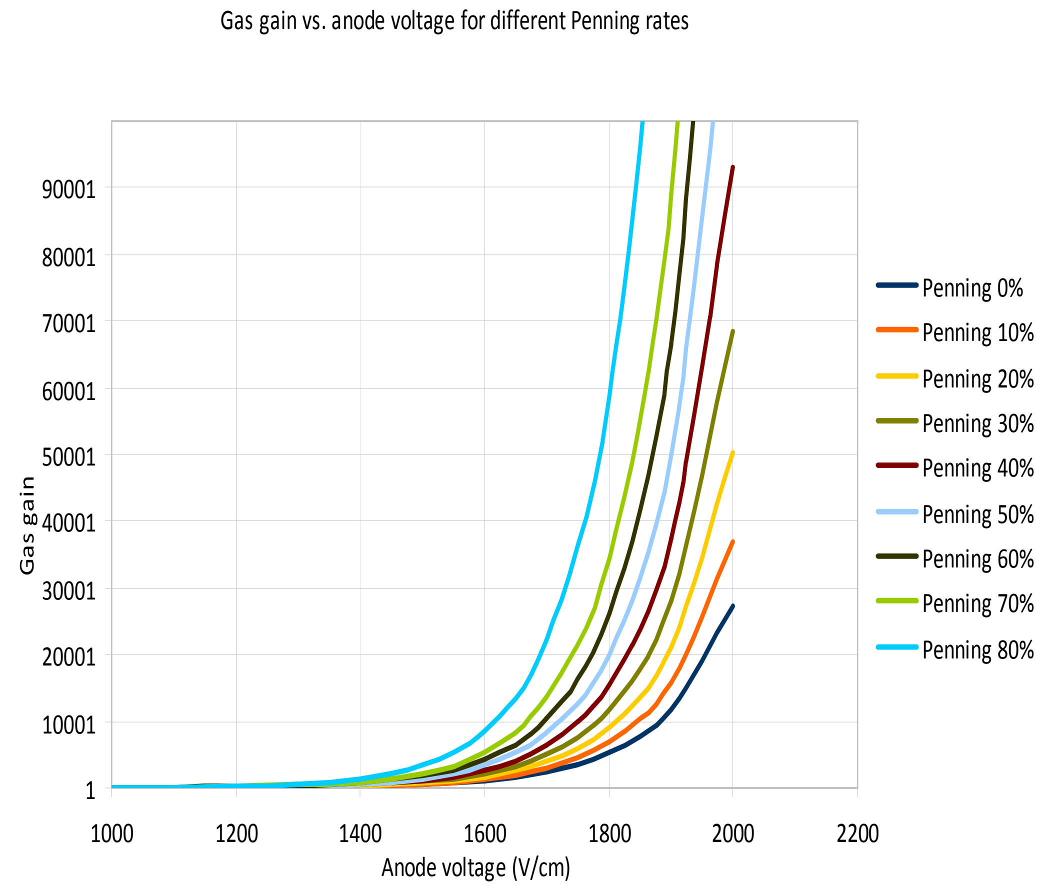
Drift path

- Plot drift path
- Avalanche measurement for gas gain determination
  - Different Penning rates
  - Electric field range
  - Steps N-E

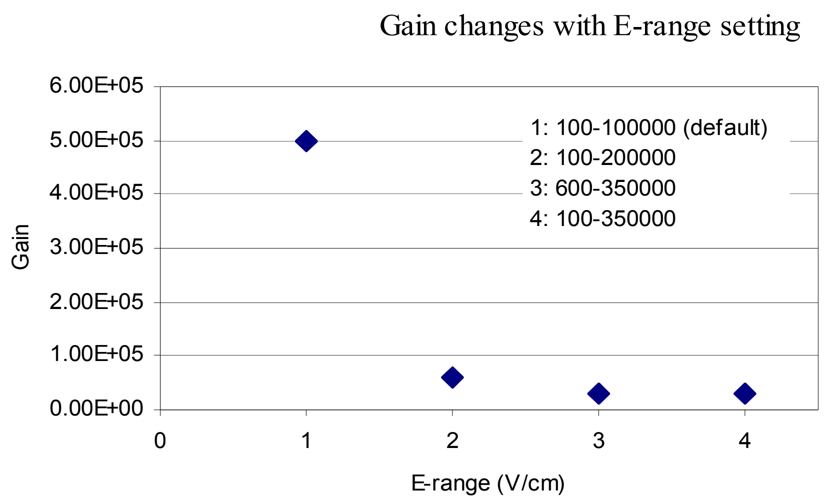


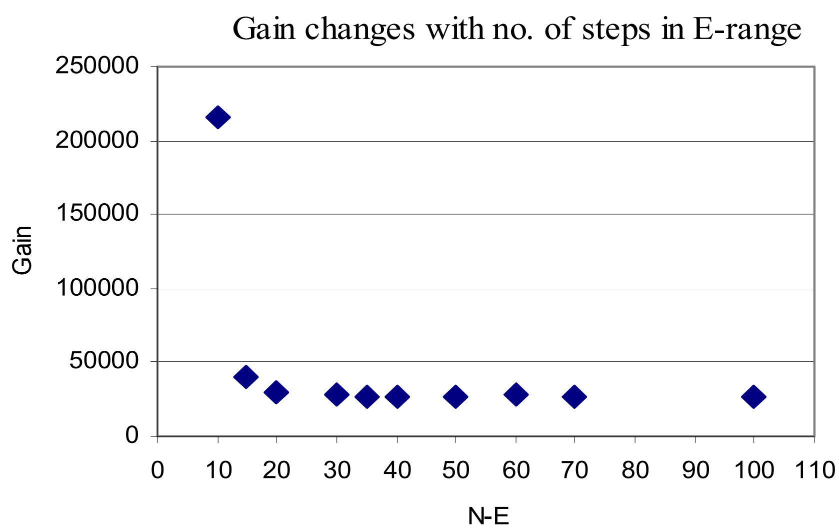
Optimise section

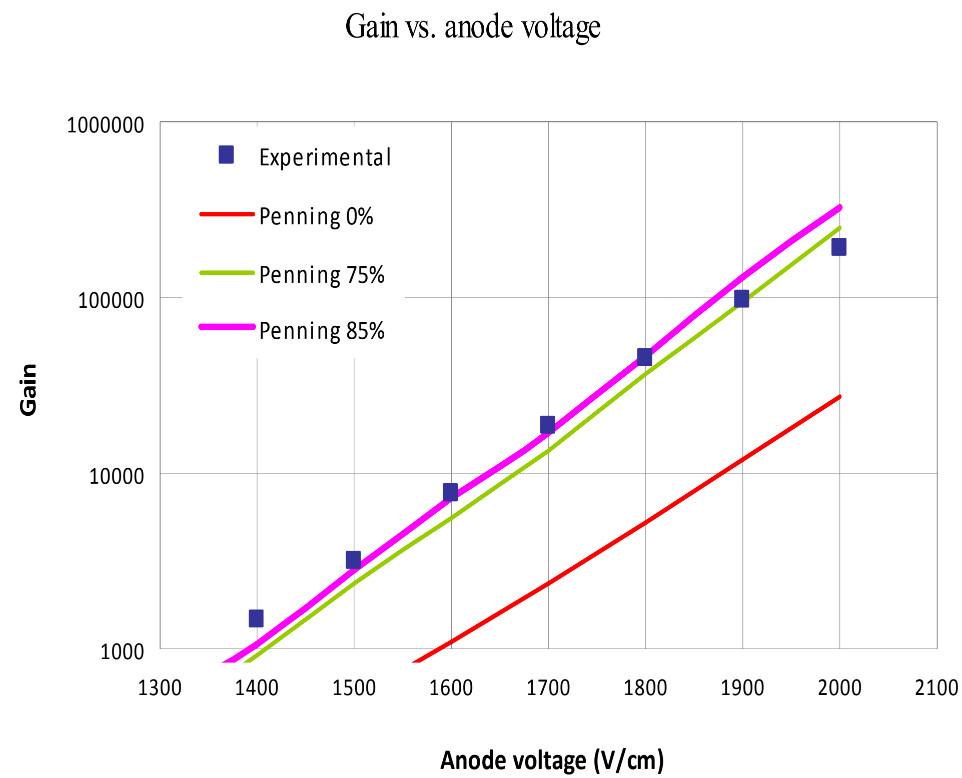
- Setting the Penning transfer rates
  - Definition: the transformation of excitation energy to ionization
  - By choosing one or more excited states and the fraction of excited molecules that will ionize another molecule



Gas gain

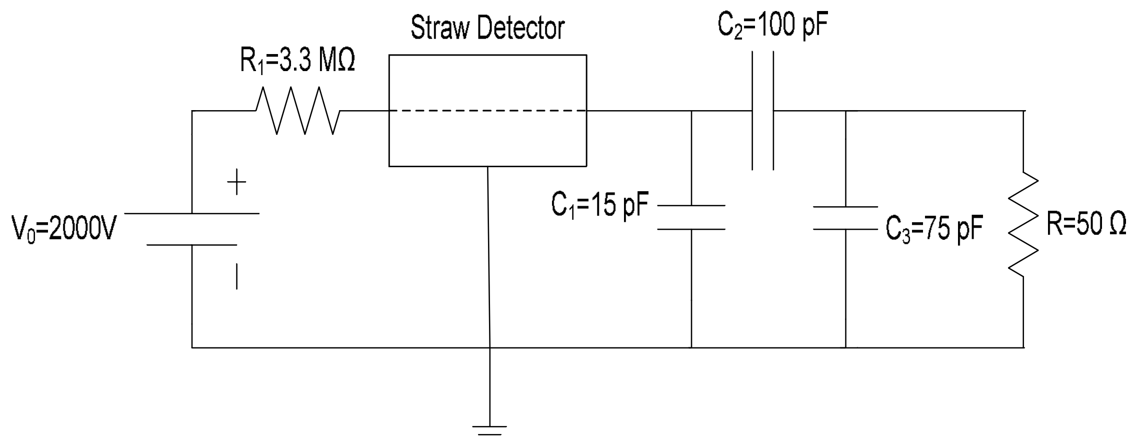

Gain changes with E-range setting
Gain
6.00E+05
5.00E+05
4.00E+05
3.00E+05
2.00E+05
1.00E+05
0.00E+00
0
1
2
3
4
E-range (V/cm)
1: 100-100000 (default)
2: 100-200000
3: 600-350000
4: 100-350000


Gain changes with no. of steps in E-range
Gain
250000
200000
150000
100000
50000
0
0 10 20 30 40 50 60 70 80 90 100 110
N-E


Gain vs. anode voltage
Gain
1000000
100000
10000
1000
1300 1400 1500 1600 1700 1800 1900 2000 2100
Anode voltage (V/cm)
Experimental
Penning 0%
Penning 75%
Penning 85%

Signal section

- Output signal of straw tube
  - Fe-55 X-ray, Energy of 5.89 keV
- The Transfer Function enables us to determine the output response to any change in an input



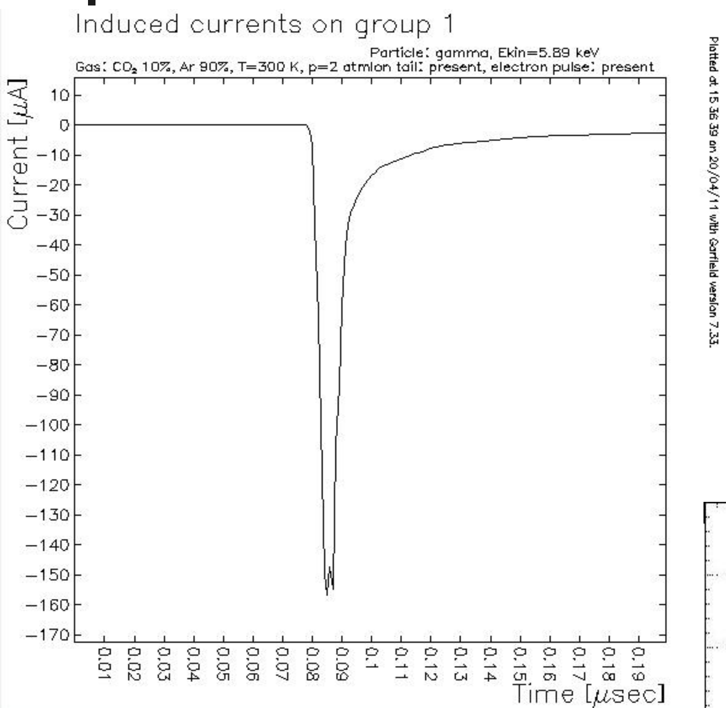
$$H(s) \equiv \frac{I_{out}(s)}{I_{in}(s)}$$

$$H(t) = a.\exp(-b.t)$$

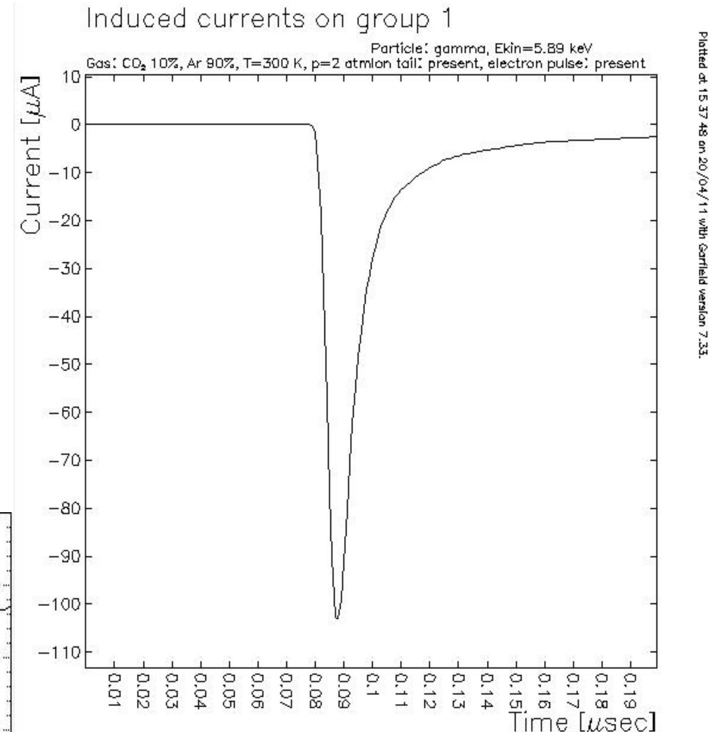
$$a = \frac{c_2}{R(c_1c_2 + c_1c_3 + c_2c_3)}$$

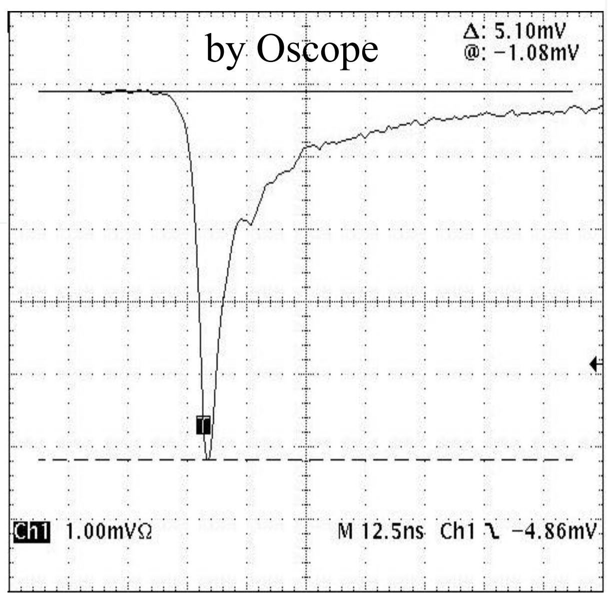
$$b = \frac{c_1 + c_2}{R(c_1c_2 + c_1c_3 + c_2c_3)}$$

Output signal



TF





Following works

- Adding noise
- Pulse shaping (various transfer functions)
- Setting the threshold
- Simulation of the central tracker in order to set track parameters (requested to the PANDA simulation group)
- Simulation of signals with GARFIELD
- Investigation of TOT (Time-Over-Threshold)
- Identification of particles by TOT technique

Thank you for attention