

TPC Simulation

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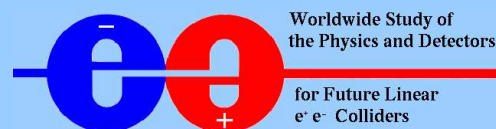
III. Physikalisches Institut B

RWTHAACHEN

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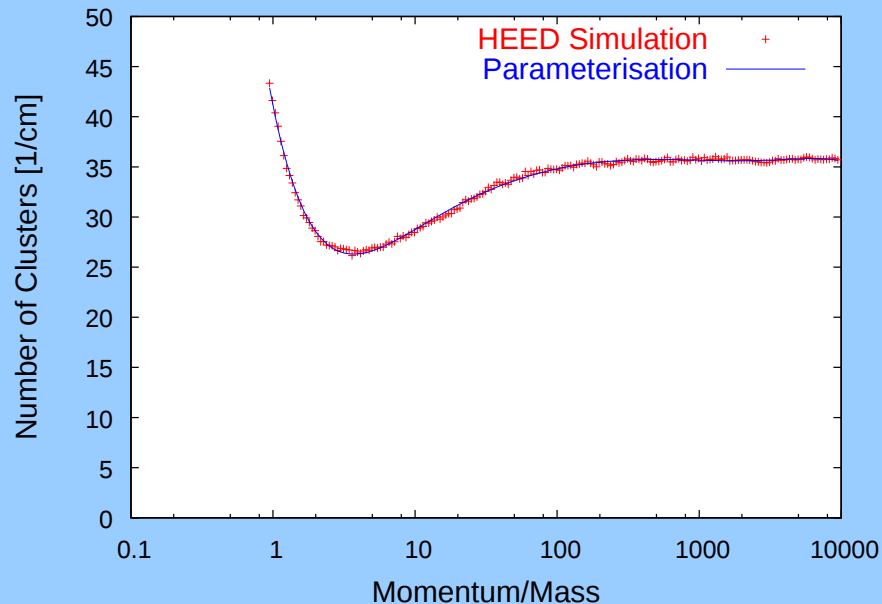


Studies of:

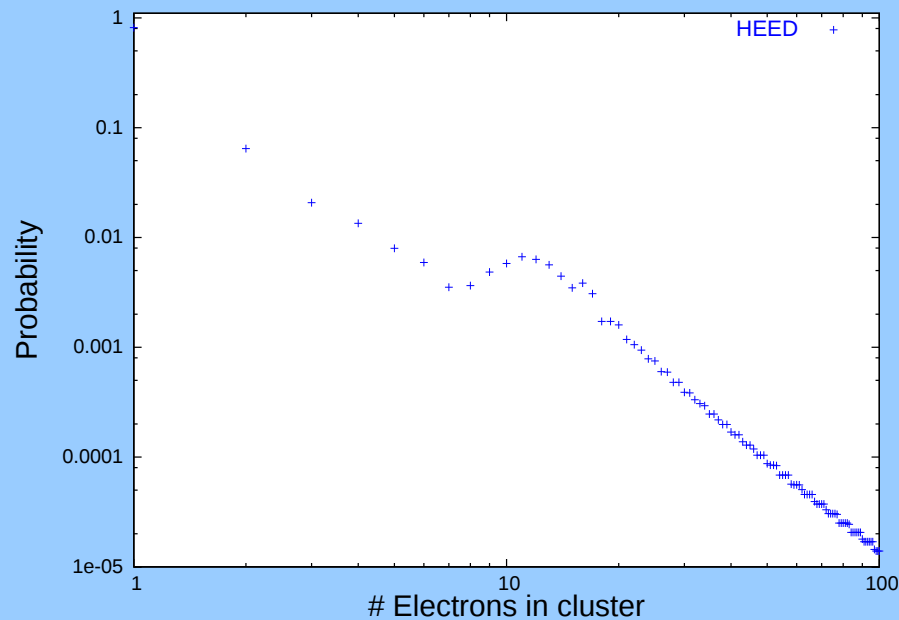
- Influence of electric and magnetic fields
- Ion backdrift
- Pad response, pad geometry

Simulation in three steps:

1. Primary ionisation
2. Drifting of electrons
3. Amplification with GEMs

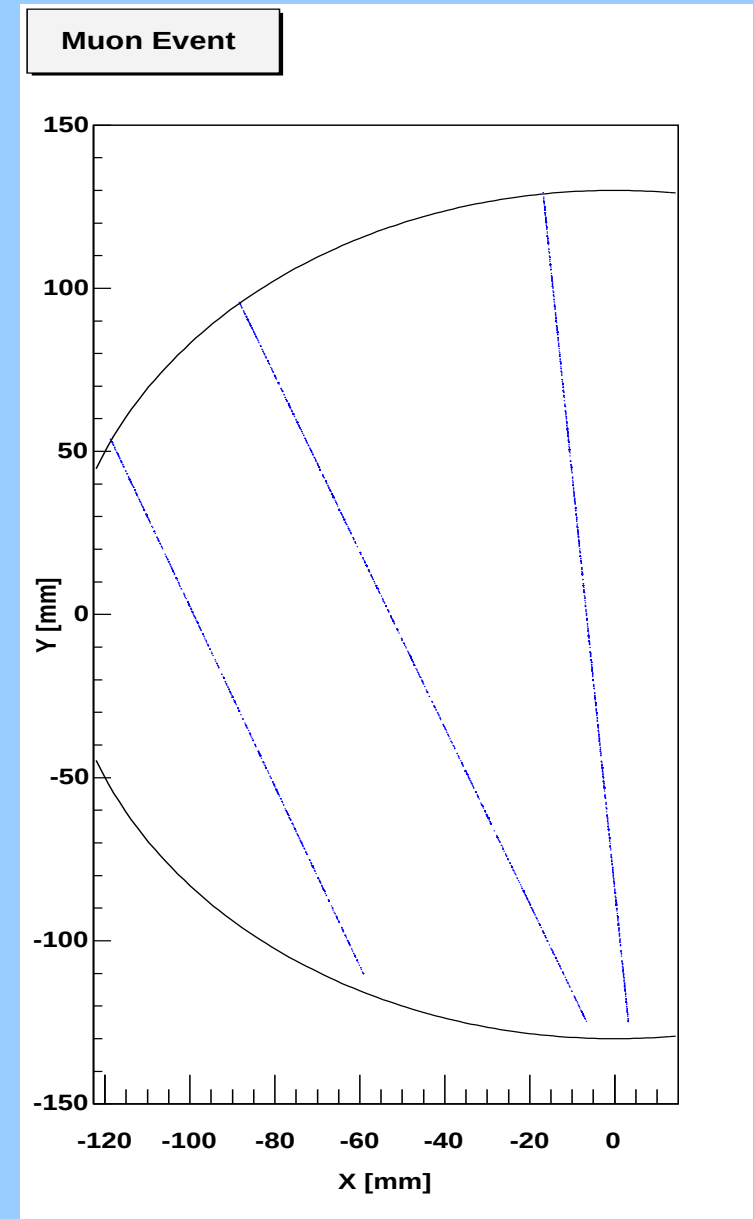
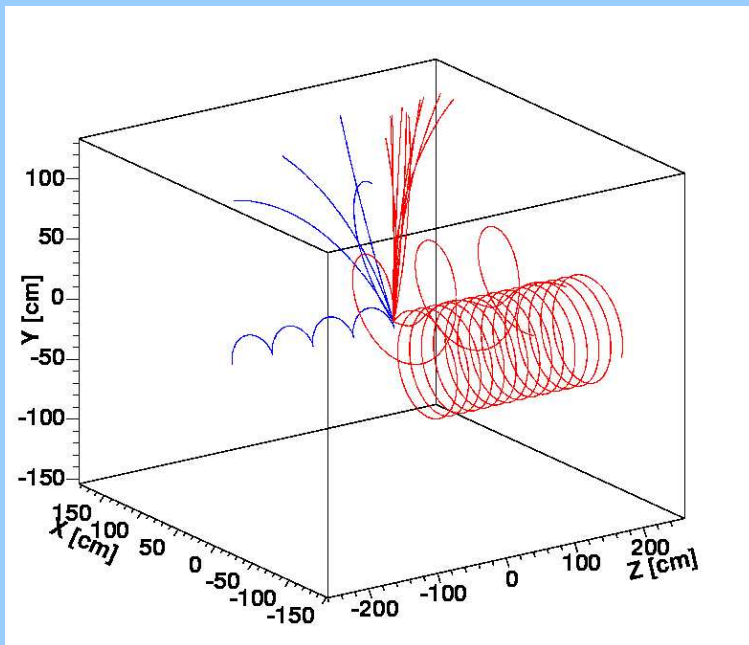


Mean number of clusters
→ Distance between clusters
from exponential distribution
with this mean value

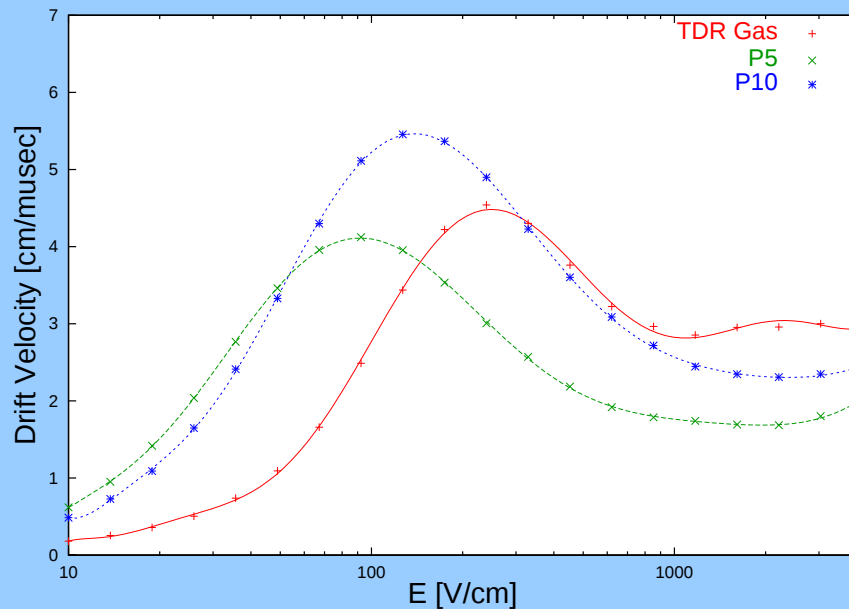


Probability for number of electrons
per cluster
→ Choose randomly according to
distribution

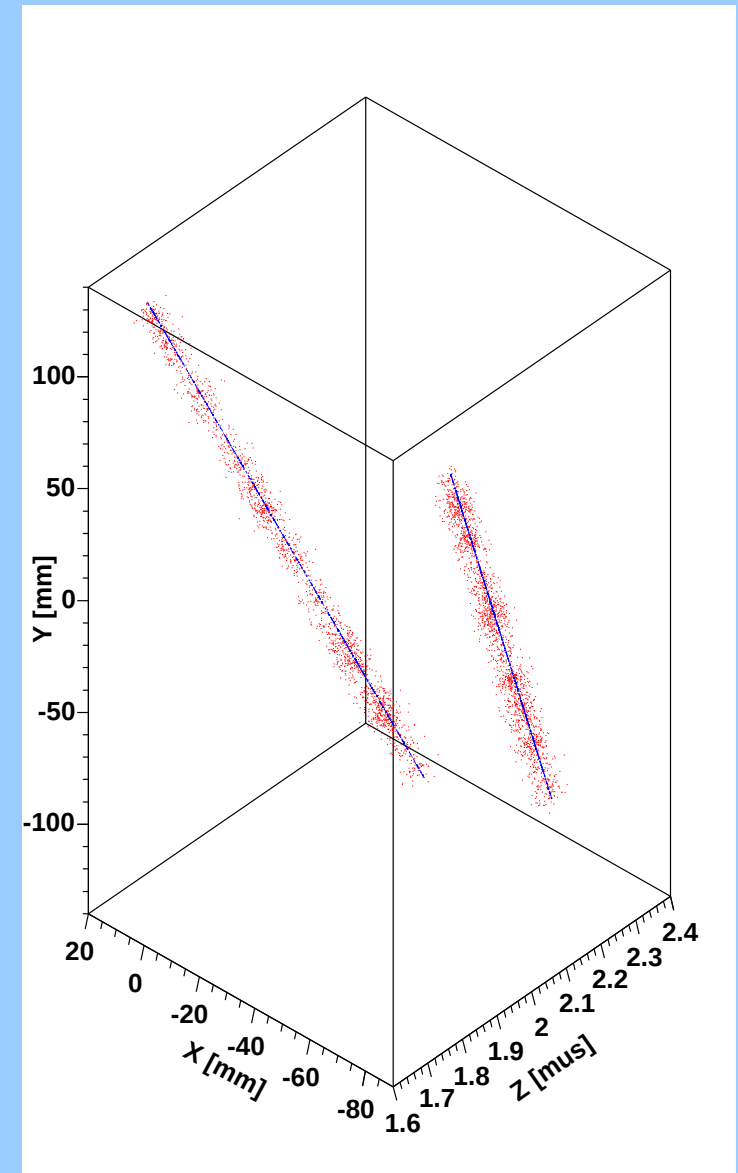
- Randomly choose distance to next cluster
- Choose # of e^- in this cluster
- 3D information possible
- B fields possible

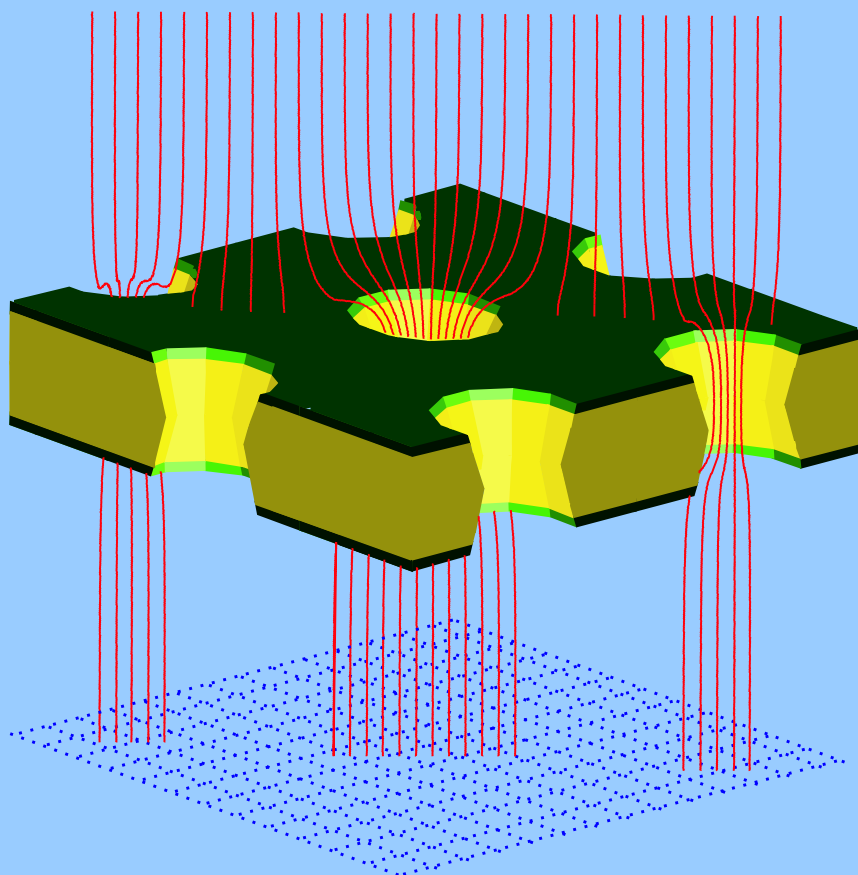


Parametrise gas properties
simulated with MAGBOLTZ



Dice coordinates after drifting
according to longitudinal and
transverse diffusion

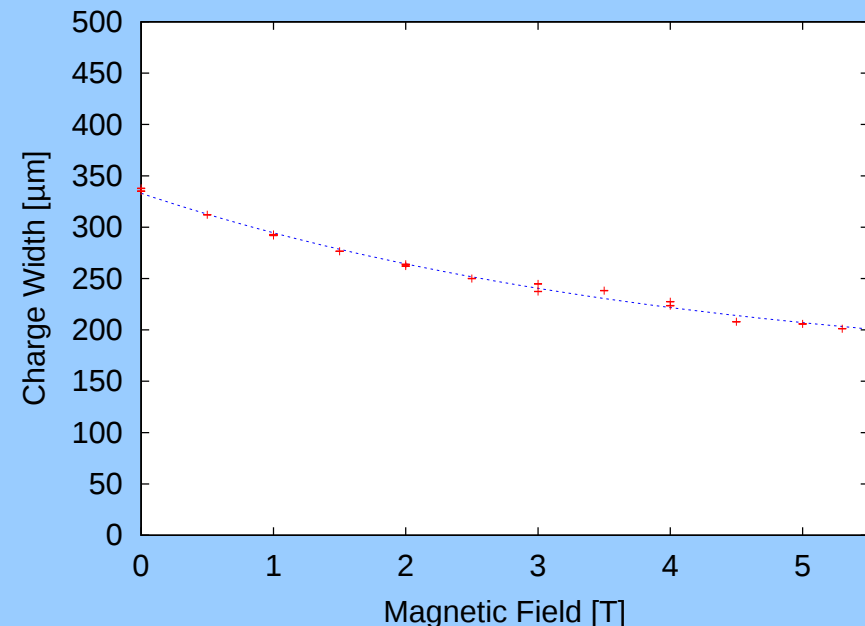
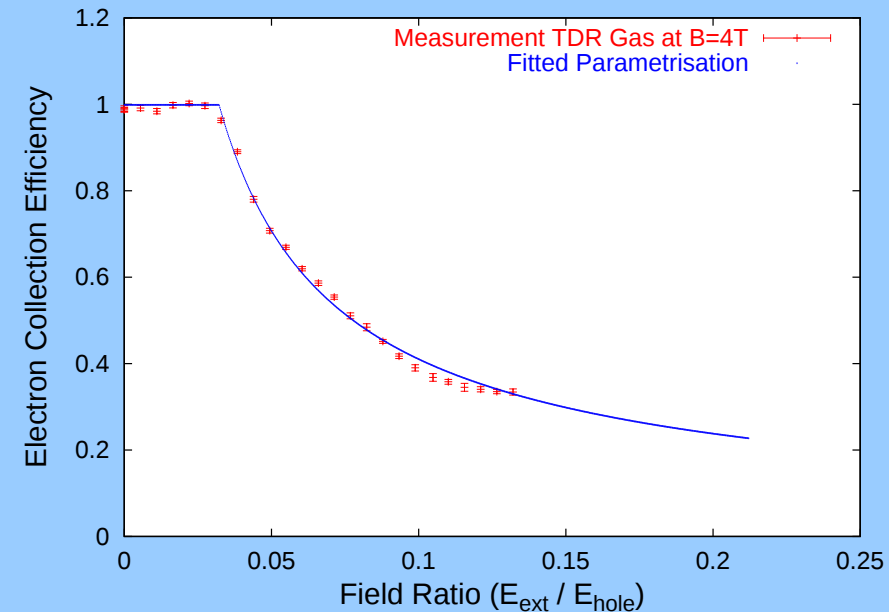




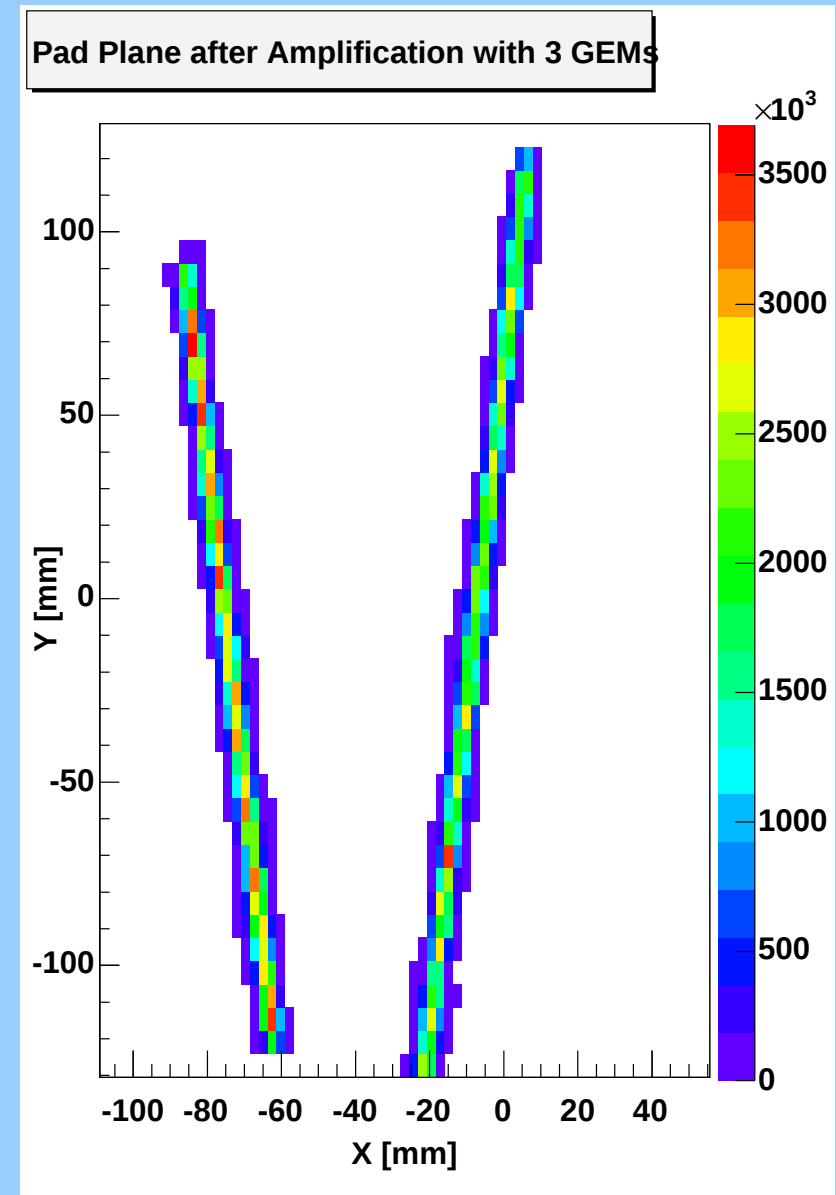
- Thickness: $5\ \mu\text{m}$ copper on $50\ \mu\text{m}$ Kapton foil
- Hole distance (pitch): $140\ \mu\text{m}$
- Hole diameter:
 $70\ \mu\text{m}$ in Cu, $50\ \mu\text{m}$ in Kapton
- Voltage for amplification:
 $250 - 450\ \text{V}$
- Field in hole:
 $\approx 60\ \text{kV/cm}$ at $400\ \text{V}$

From measurements:

1. Parametrisation of charge transfer in triple GEM structure: collection, extraction, gain
2. Charge broadening only due to diffusion between GEMs
→ Simulate diffusion with Magboltz



- Calculate number of secondary e^- from charge transfer combined with binomial statistic
- Integrate over 2D gaussian with sigma of charge cloud to get charge on pads
→ Voxel information: charge on channel c in timeslice t



TPCSim v.1.0

1. Create Tracks for Pythia Events

Inputfile: ...

Magnetic Field B: [T]

TPC radius: [mm]

TPC Length / 2: [mm]

#e- pro Cluster Infofile: ...

2. Drift Tracks

Inputfile: ...

Gas: (TDR, P5, P10)

Electric Field E: [V/cm]

3. Amplification and Creation of Voxl

Inputfile: ...

Readout Frequency: [MHz]

Pad Width: [mm] Pad Height: [mm]

Number of Pads: Pads in Row:

Offset of Padplane to Center of TPC: x [mm] y [mm]

Electronic Cut for Charge on each Voxl: # e-

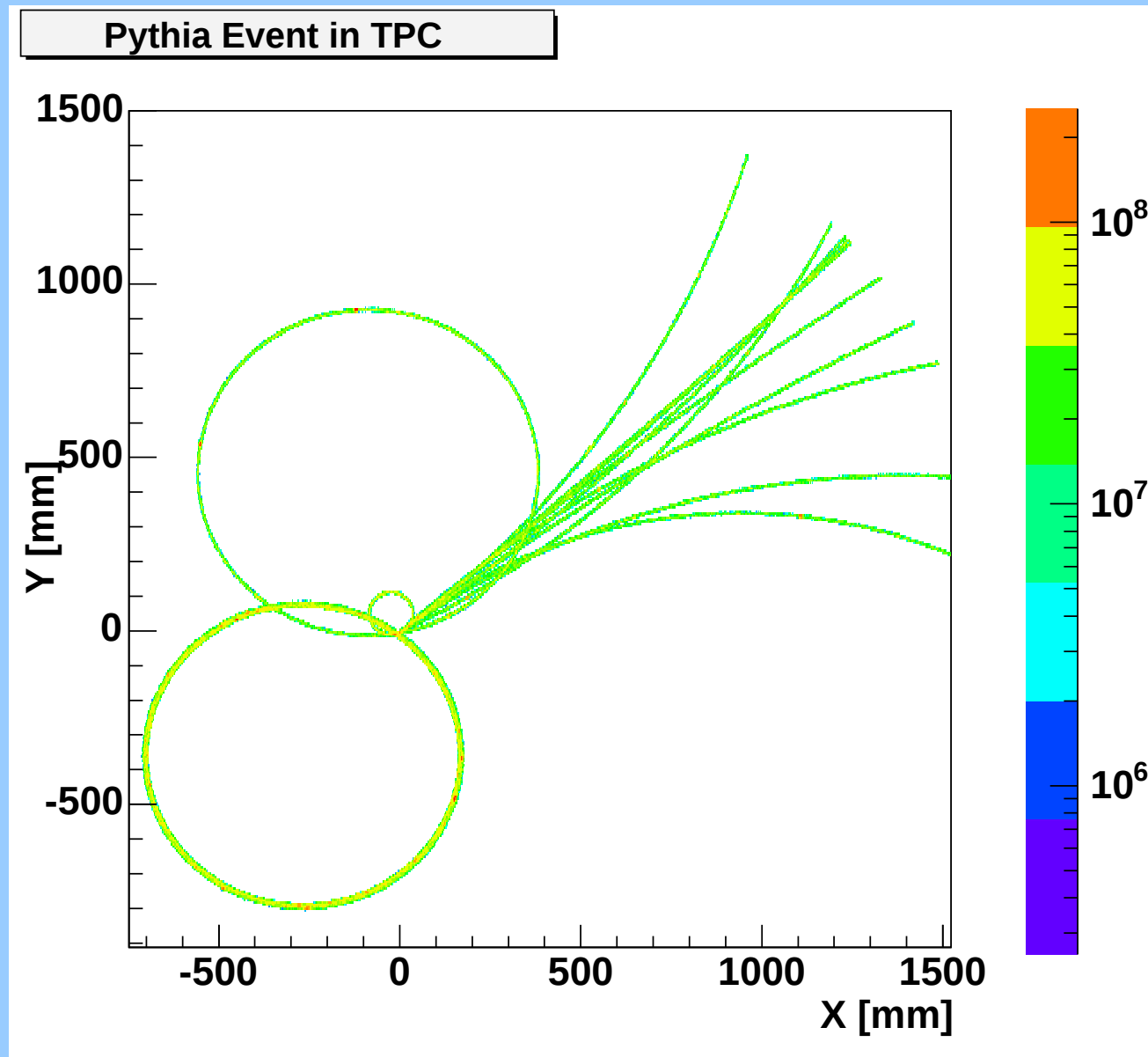
GEM Settings

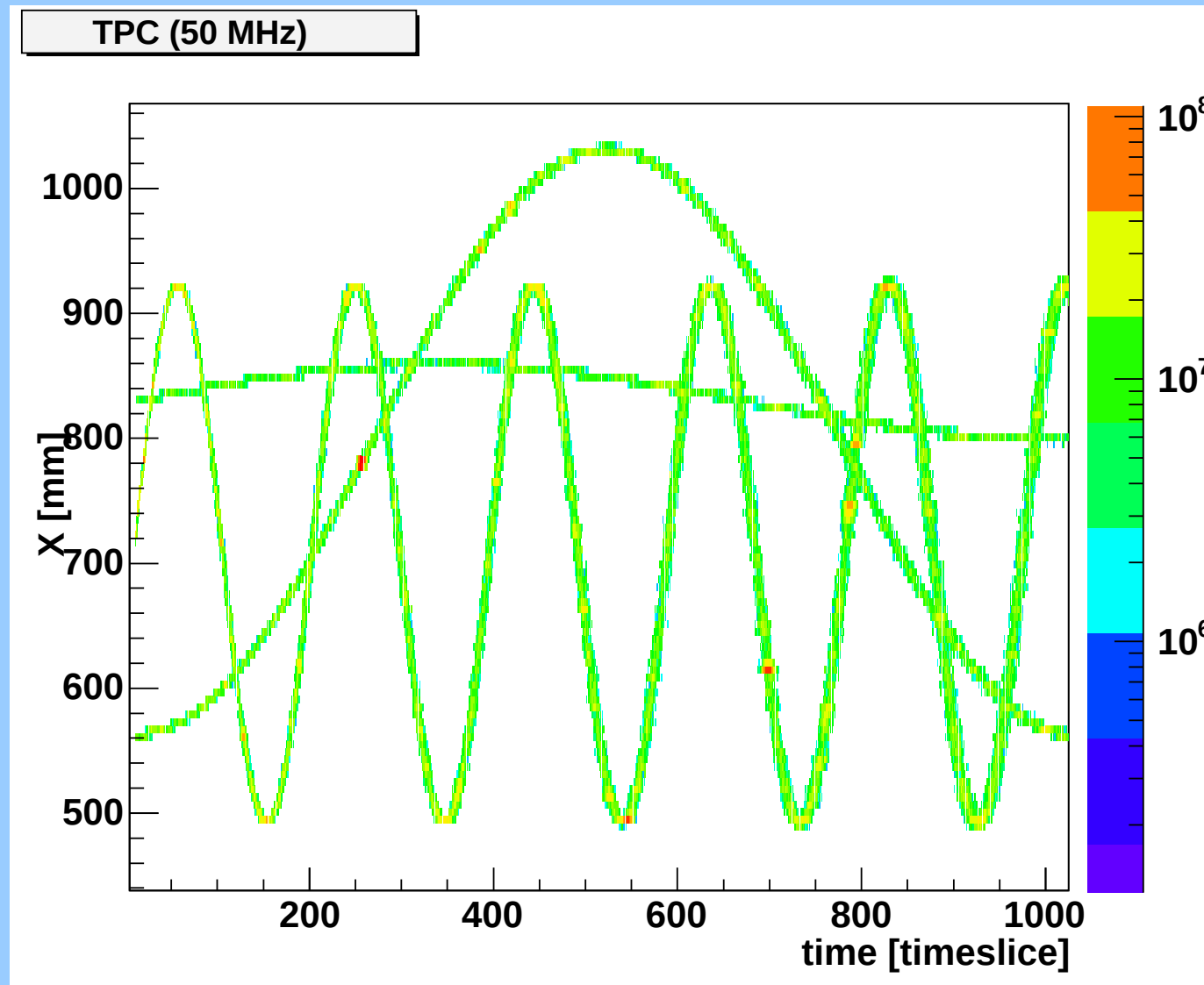
U GEM 1: [V]
Transfer Field 1: [V/cm]
U GEM 2: [V]
Transfer Field 2: [V/cm]
U GEM 3: [V]
Induction Field: [V/cm]

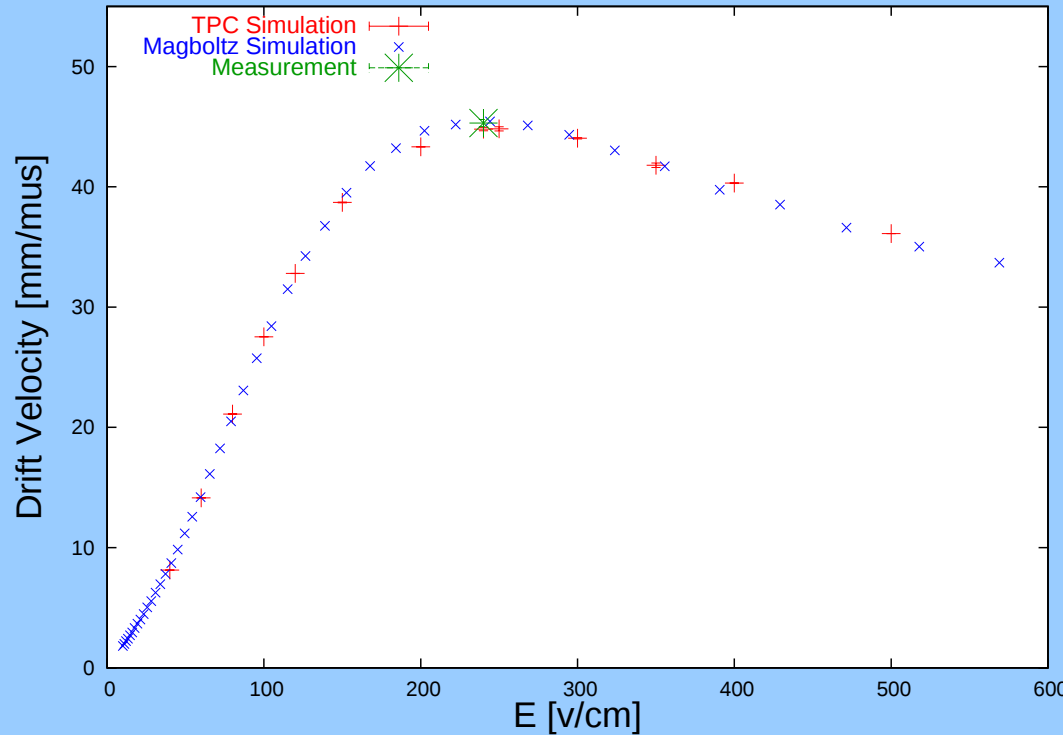
Parameter File: ...

Program Output

```
Opened
/.automount/achdsrv2/institut_3b/mue
Drifting for TDR gas with E=240
V/cm,
dl=283.994 [mum/sqrt(cm)]
v_d=44.7989 [mm/mus]
d_t=475.95 [mum/sqrt(cm)]
1128 electrons on track: 0
2315 electrons on track: 100
1889 electrons on track: 200
1373 electrons on track: 300
1632 electrons on track: 400
1691 electrons on track: 500
2366 electrons on track: 600
1721 electrons on track: 700
1871 electrons on track: 800
1730 electrons on track: 900
DRIFTING FINISHED
Opened
/.automount/achdsrv2/institut_3b/mue
Drifting for TDR gas with E=240
V/cm,
dl=283.994 [mum/sqrt(cm)]
v_d=44.7989 [mm/mus]
d_t=475.95 [mum/sqrt(cm)]
448 Pads in 14 rows and 32
columns.
Offset of Active Area in x: 38.4 in y:
54.8
Parameter file read successfully
Event 0 done
```

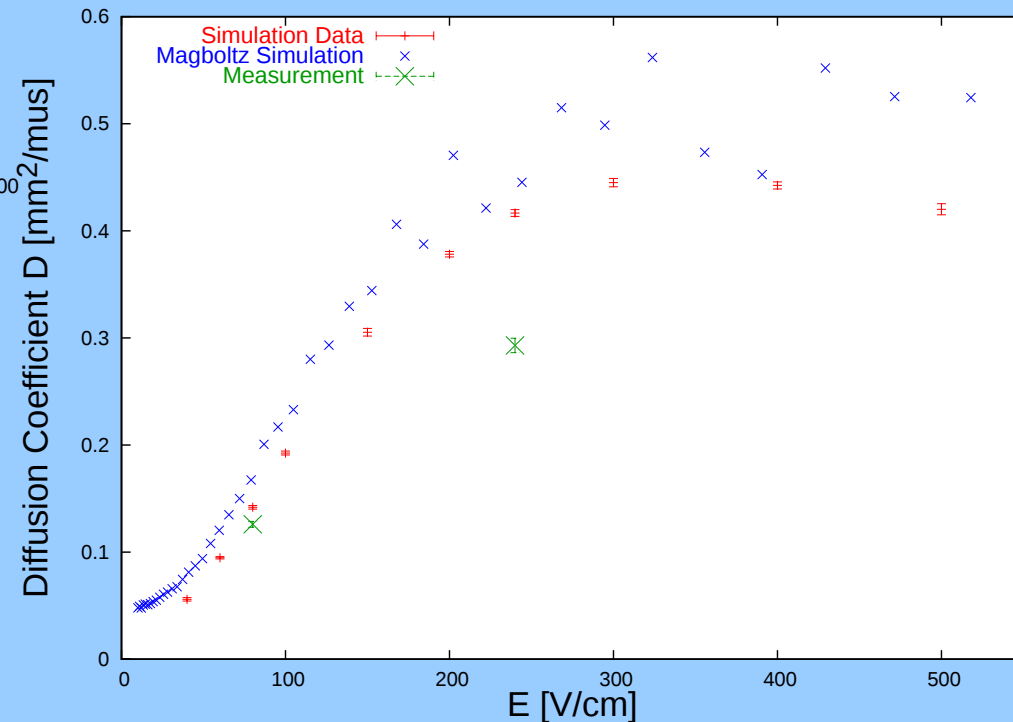






Drift velocity for
TDR Gas (Ar/CH₄/CO₂ 93/5/2)

Transverse diffusion
→ Problem with Magboltz or
measurement ?



Advantages:

- Simulation independent of big simulation packages
- Amplification with GEMs (different settings)
- Magnetic fields and 3D view possible
- Many variable input parameters for systematic studies

Disadvantages:

- No spatial propagation of δ -electrons

Outlook:

- Understand discrepancy in diffusion results
- Transfer to new data format LCIO / MARLIN
- More systematic studies