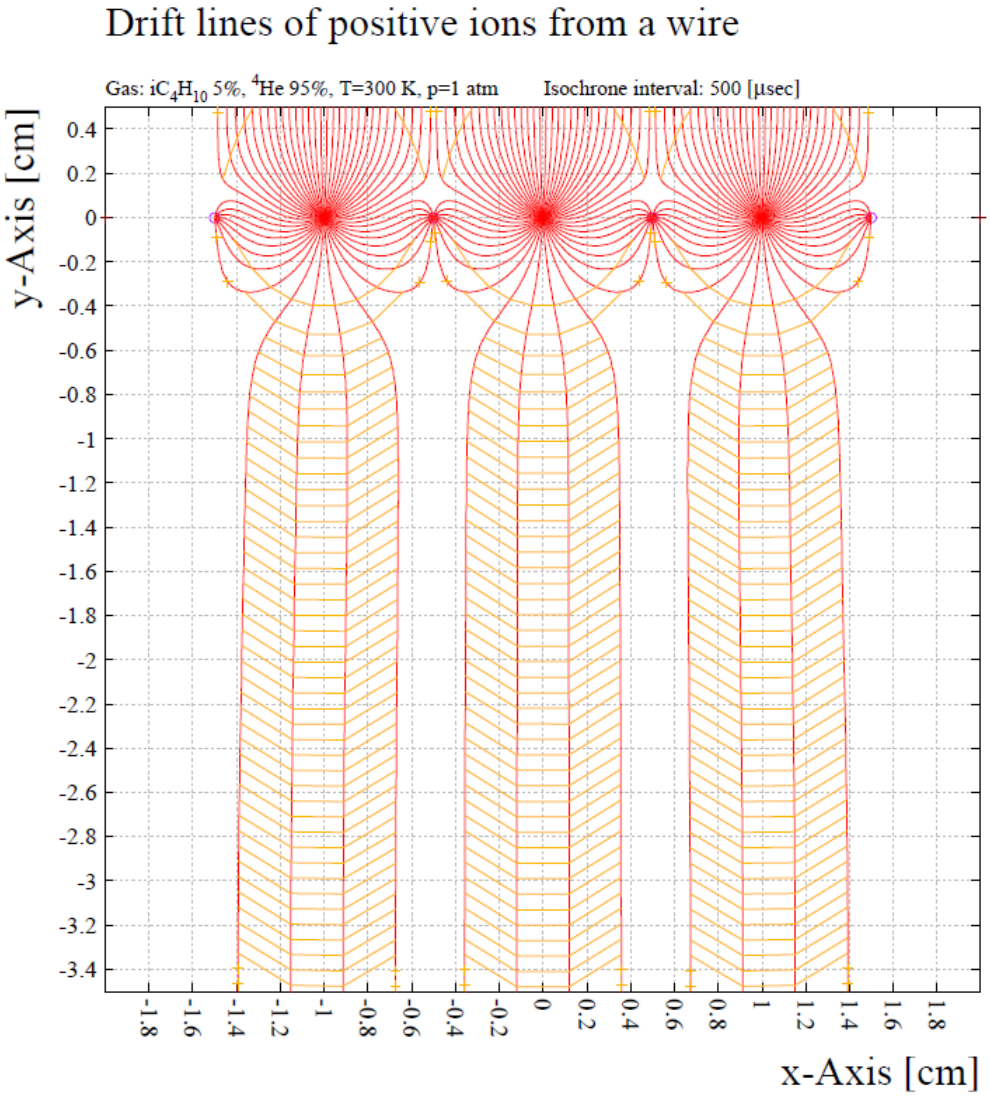
Cluster Counting with FDC-like chambers

He gas mixture drift chamber with wide homogenous drift space:

- Why cluster counting?
  - measuring dE/dx for PID
  - cluster number – Poisson distr.
  - charge – Landau distr.
- Main problems: GHz sampling, single electron sensitivity
- Using He-based gas mixtures – small cluster density allows (?) to use 250MHz or 125MHz fADC, but require longer drift to have statistics
- FDC-like structure: cathode, wire plane at 3.5cm, cathode strips at 4cm, ground plane at 4.5cm, next cell cathode, wire plane and so on …



Cluster Counting with FDC-like chamber

- 95% He 5% iC_4H_{10} gives:

• gain of ~10^5 at +1240 V / 0 V field/sense wires

• ~100V/cm in the drift space

• longitudinal diffusion of ~0.3 cm^0.5

• very low drift velocity of ~5μm/ns

• ~8 clusters/cm: ~1250μm mean distance or ~250ns mean time between clusters >> 8ns, or 4ns sampling time

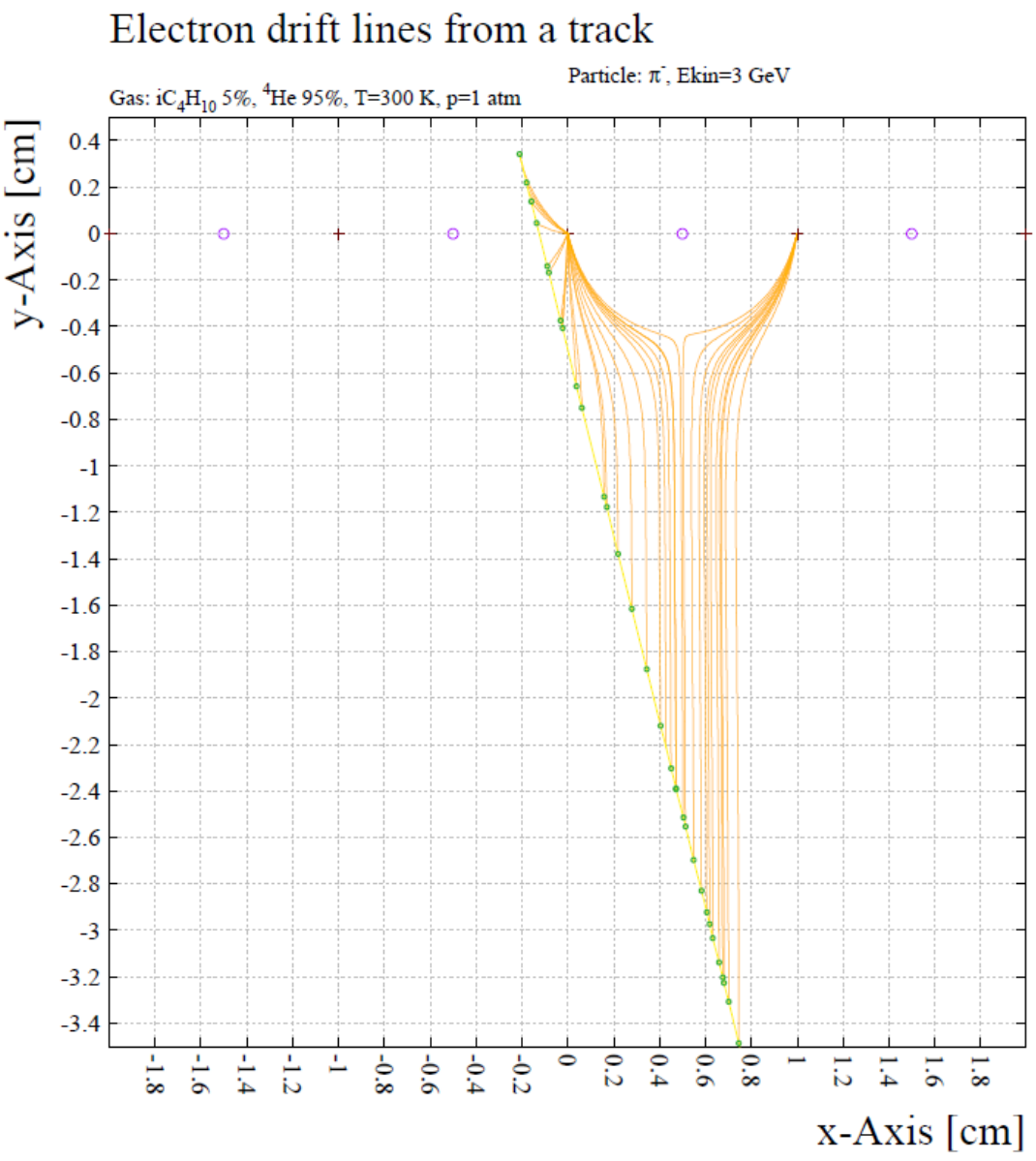
• 1250μm > ~600μm diffusion for 3.5cm drift

- Statistics if using 16 such chambers:

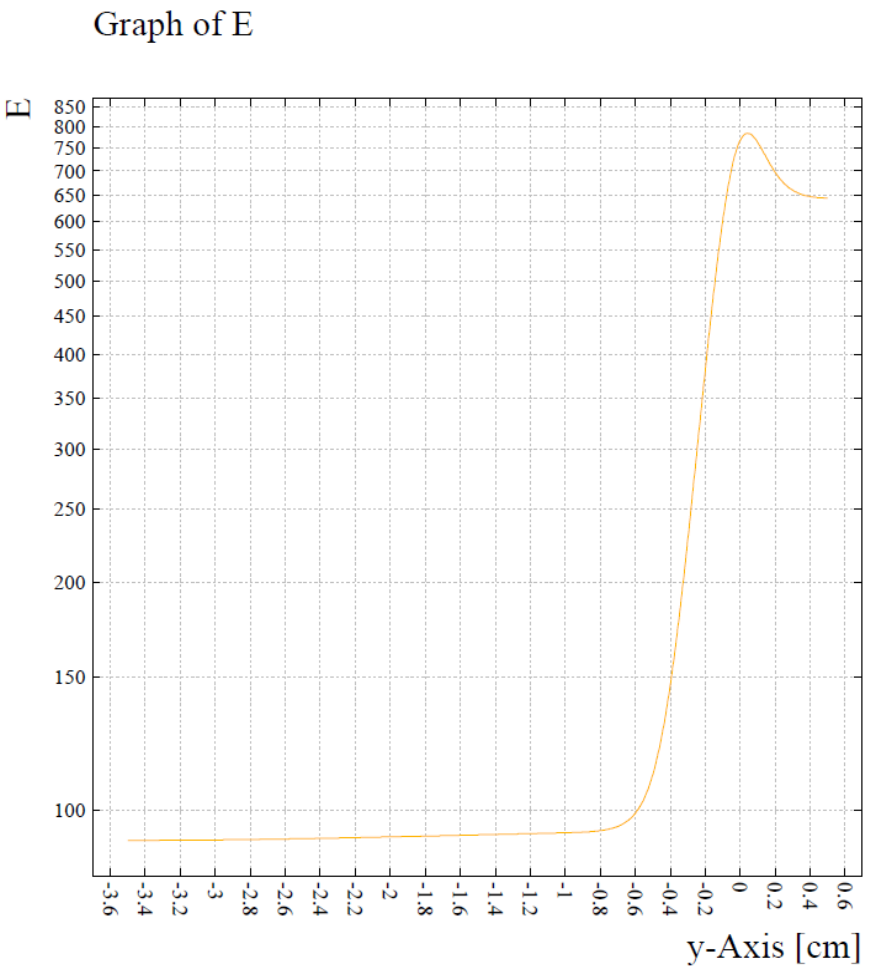
• 30 clusters per chamber

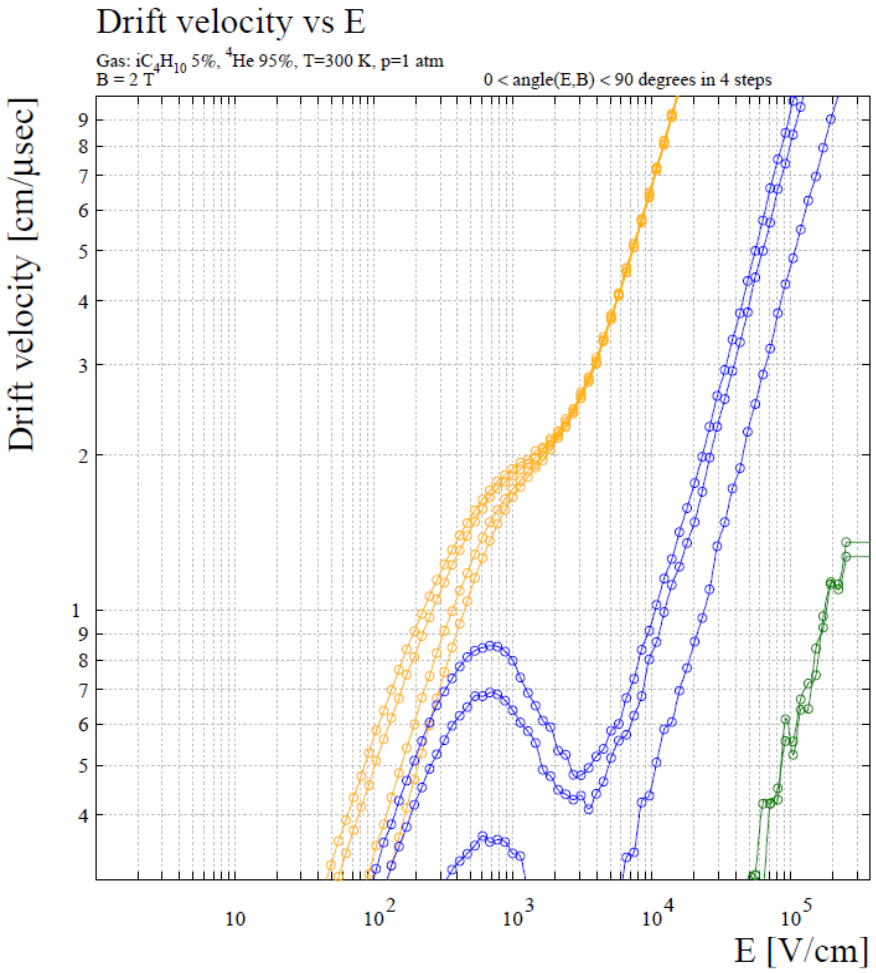
• 480 clusters per track

• ~5% statistical error, to be compared to ~15% difference in the clusters created from pi and K above 3GeV

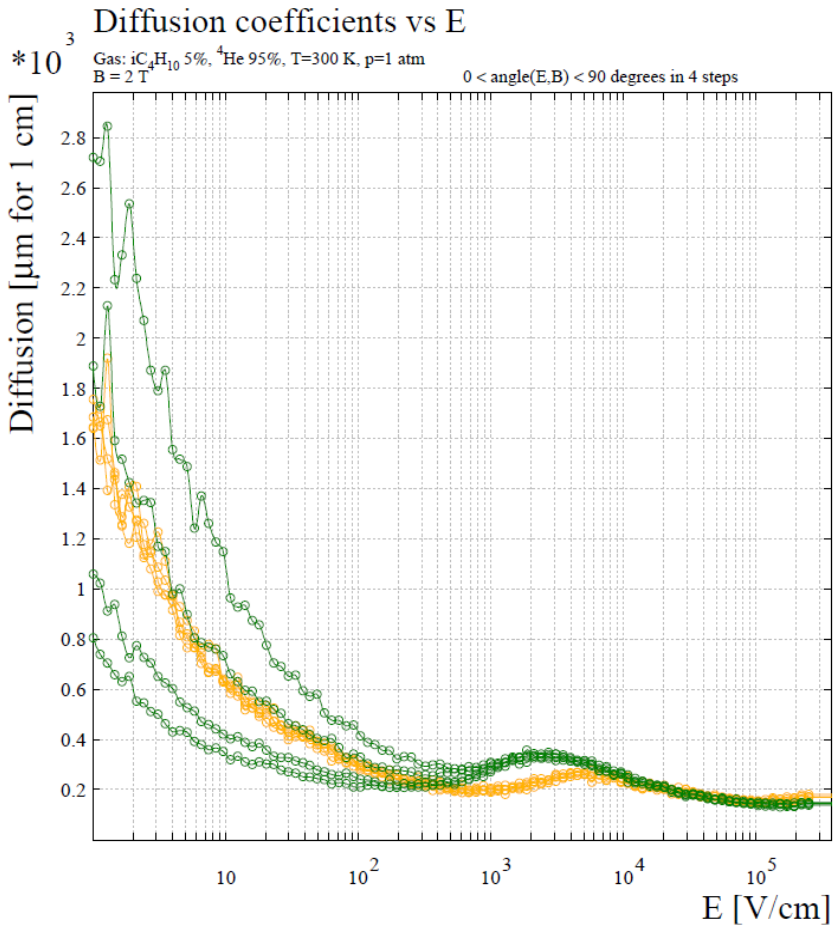


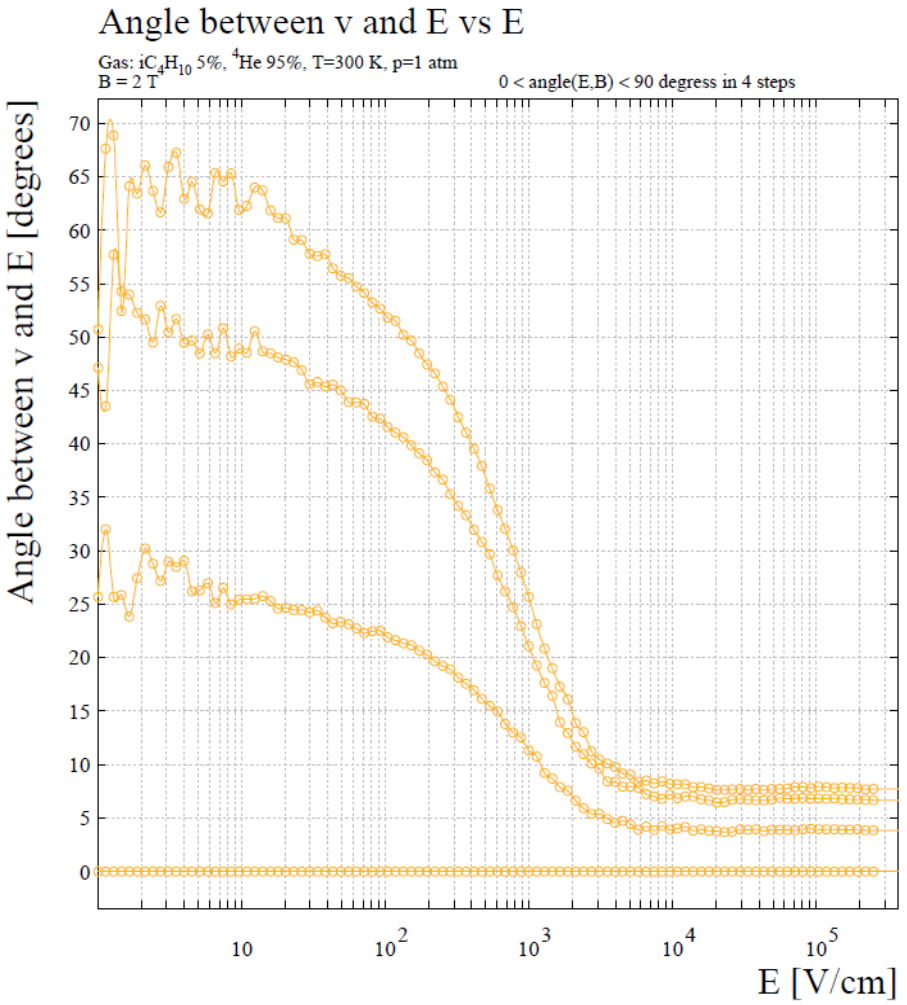
Cluster Counting with FDC-like chamber





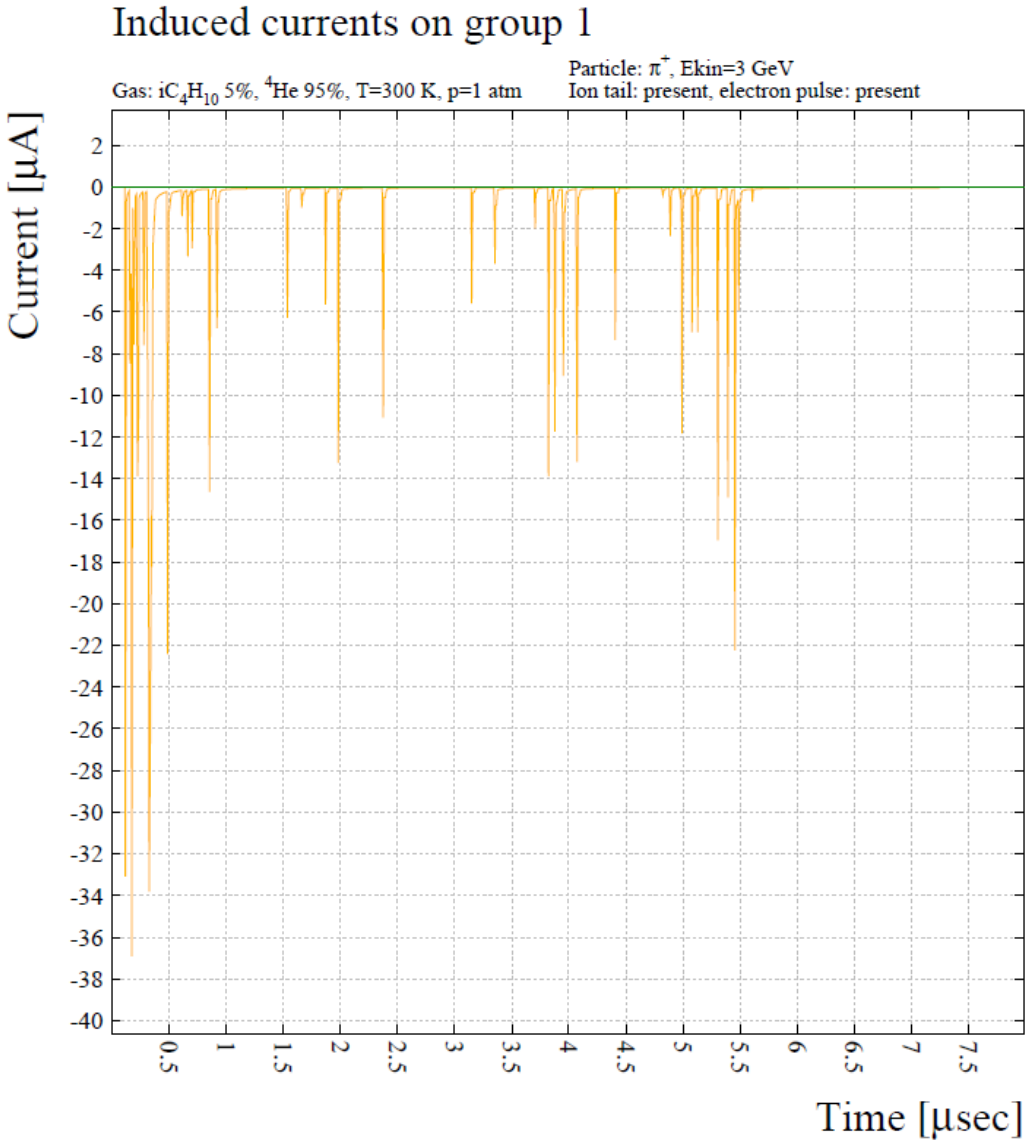
Cluster Counting with FDC-like chamber





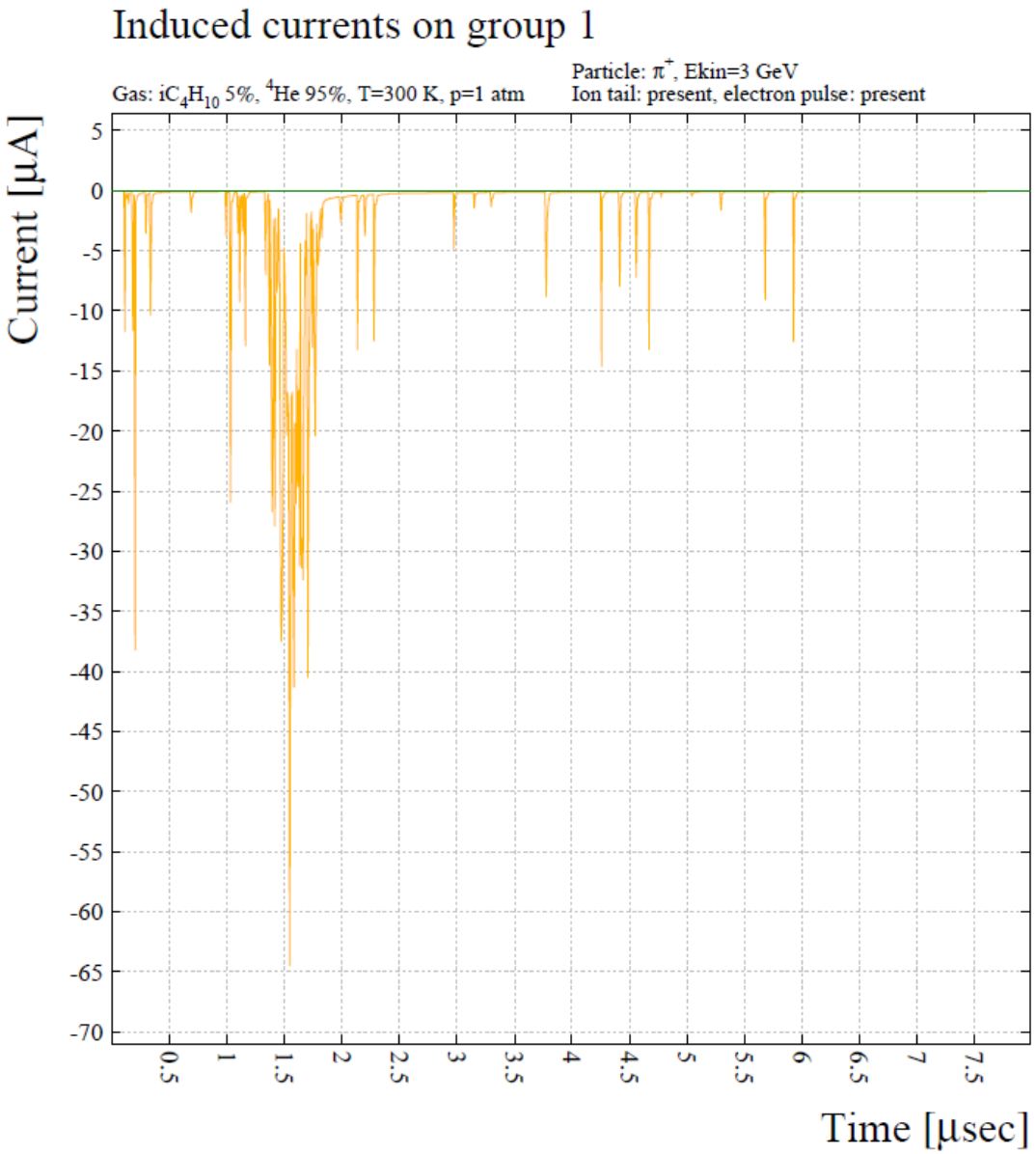
Cluster Counting with FDC-like chamber

- Signal simulations using Garfield:
- both electron pulse and ion tail taken into account
- no delta electron tracking
- initial resolution of 2ns
- folding with PreAmp-Cable-Shaper response functions
- sampling with 8ns or 4ns
- Max drift time up to 7 μs
- Results presented with simplification of this scheme, but checked for one momentum at lower statistics



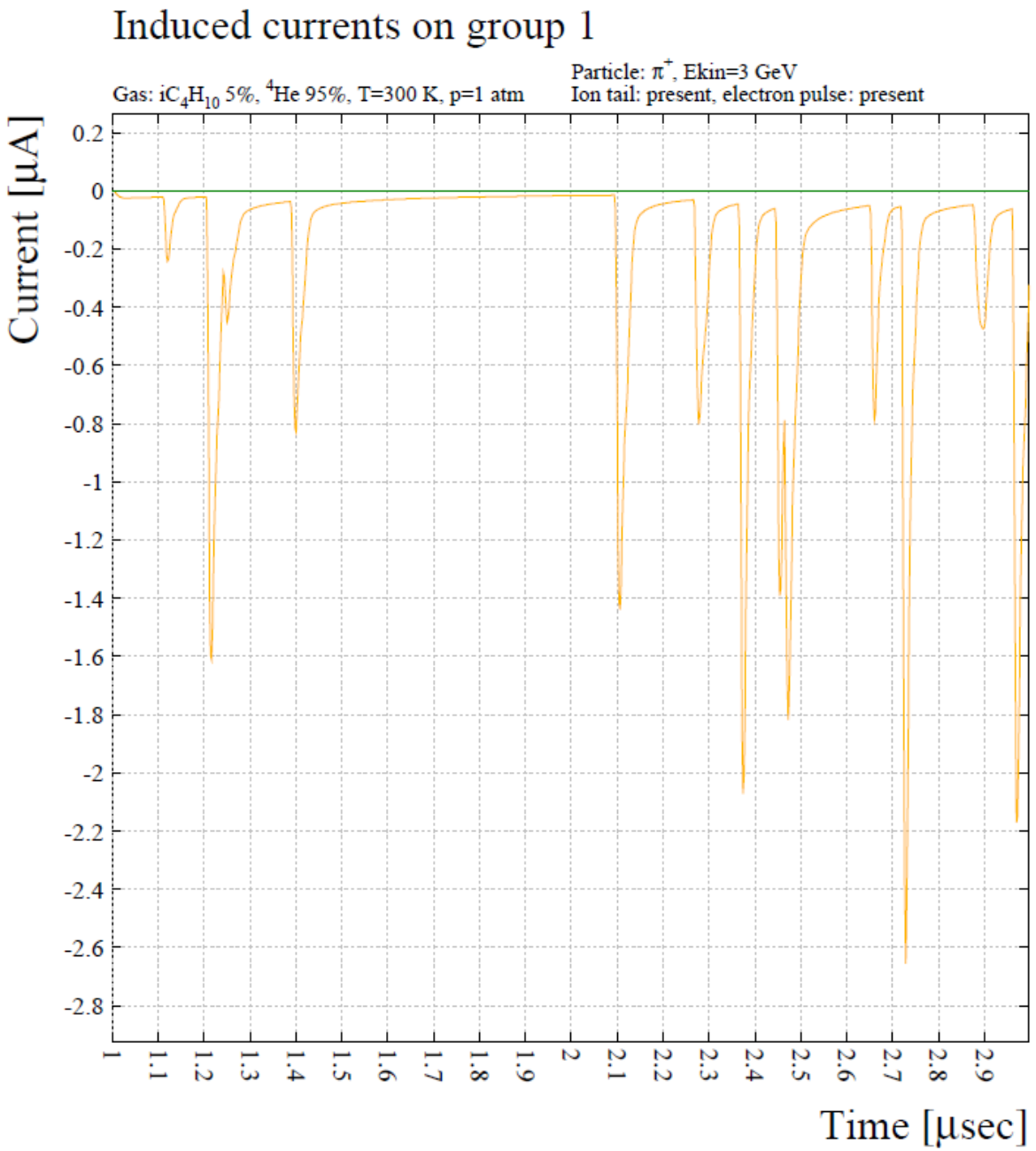
Cluster Counting with FDC-like chamber

- Typical delta electron:



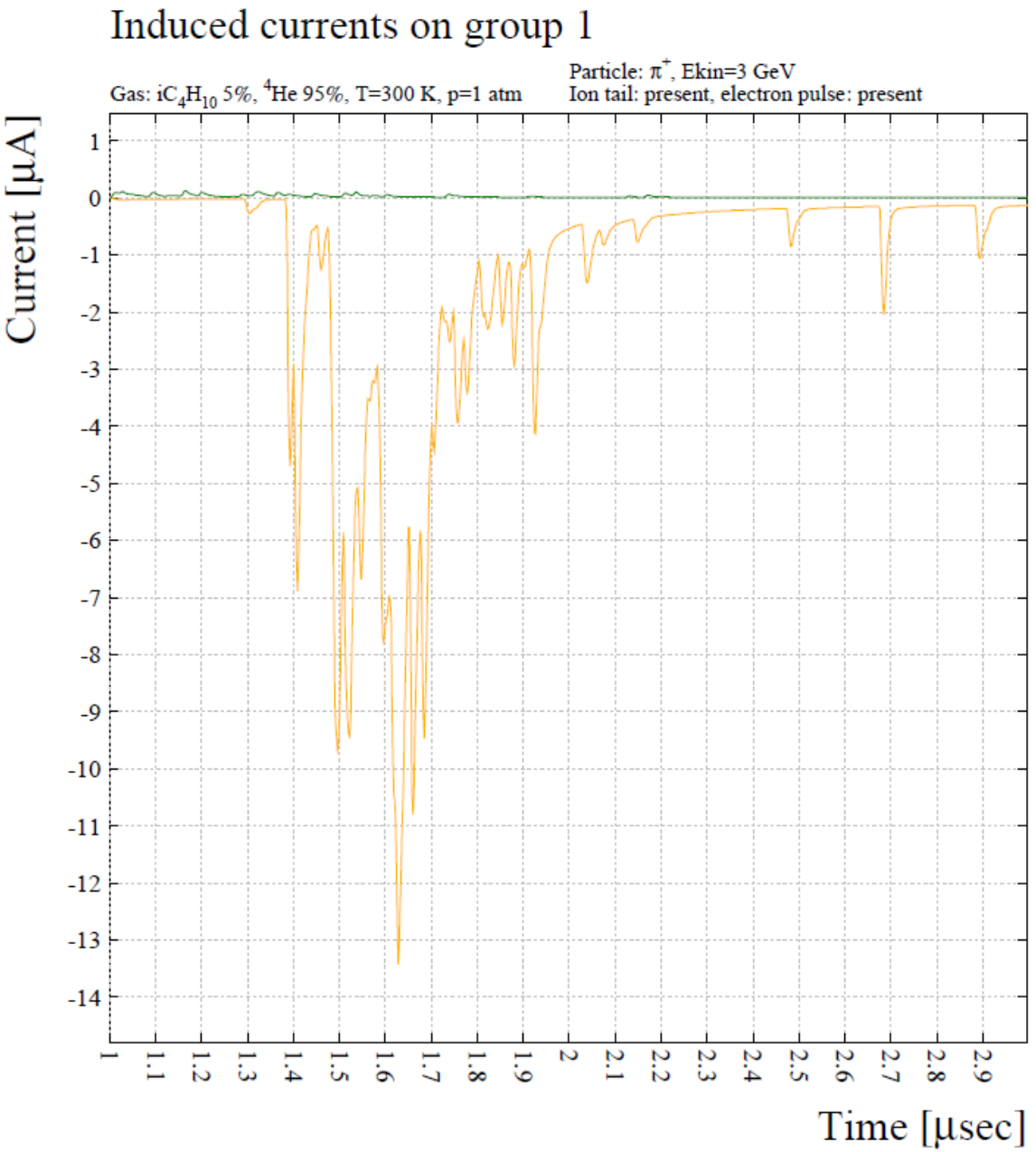
Cluster Counting with FDC-like chamber

- Zoomed example:



Cluster Counting with FDC-like chamber

- Zoomed delta electron example:

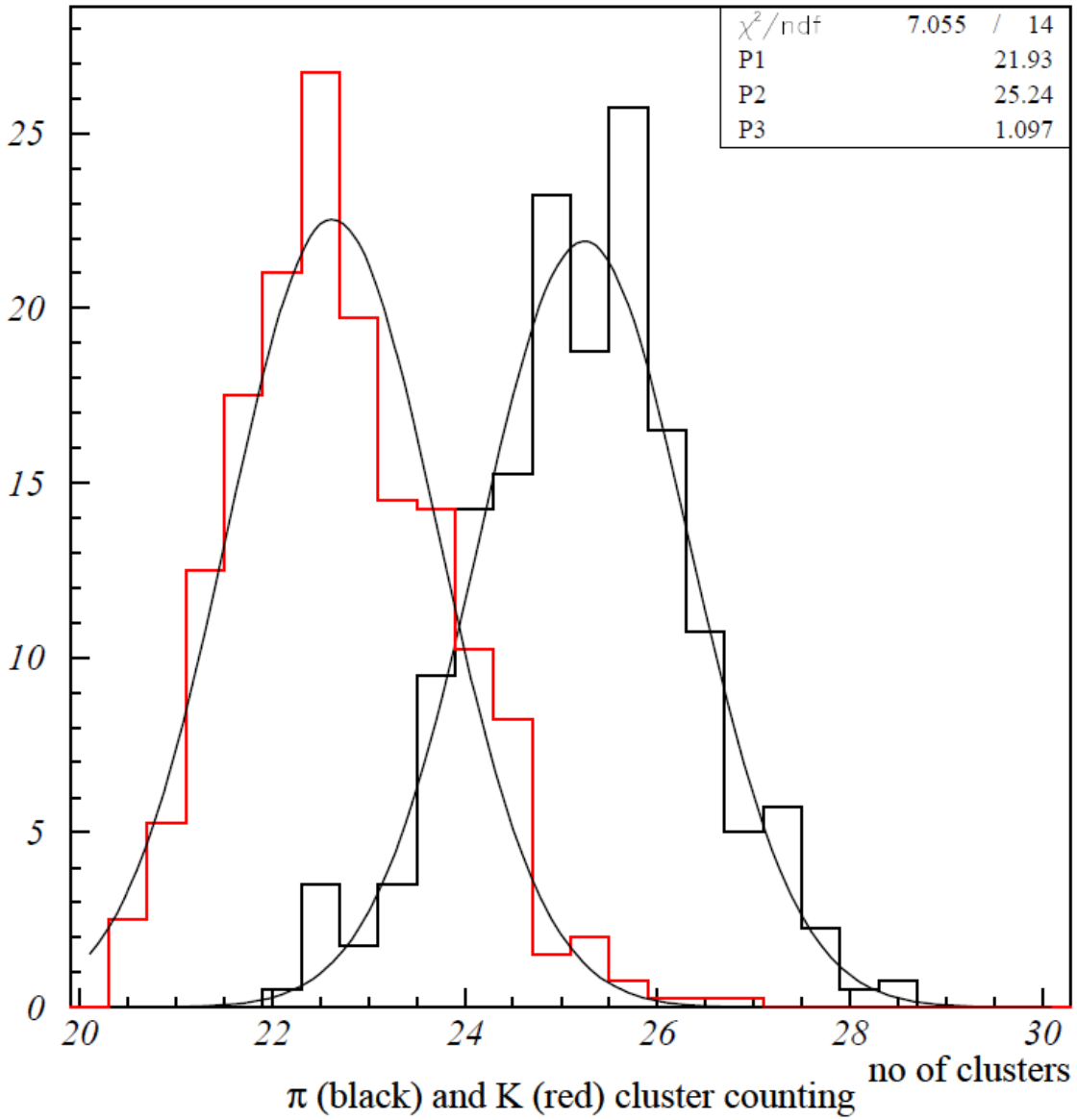


Cluster Counting with FDC-like chamber

- Garfield simulation of K/pi separation with 4ns sampling:

Number of clusters counted for K and π at 3 GeV

VERY PRELIMINARY



Cluster Counting with FDC-like chamber

- Garfield simulation of K/pi separation with 8ns / 4ns sampling:

Number of sigmas between the peaks vs Particle momentum

VERY PRELIMINARY