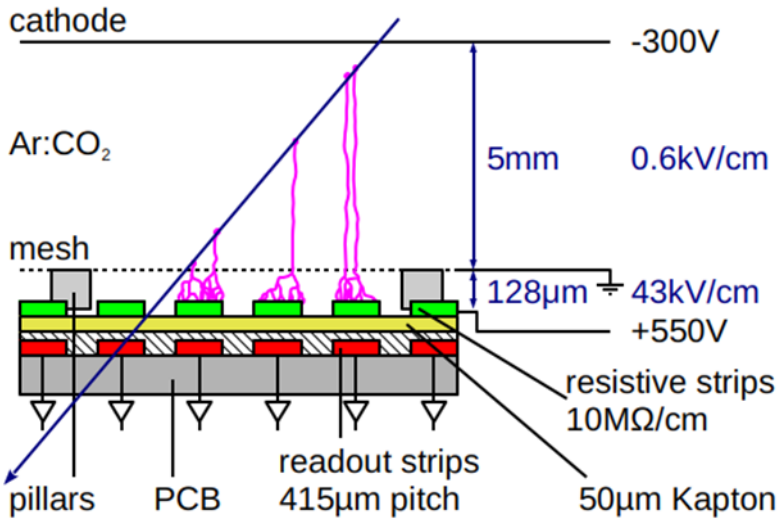
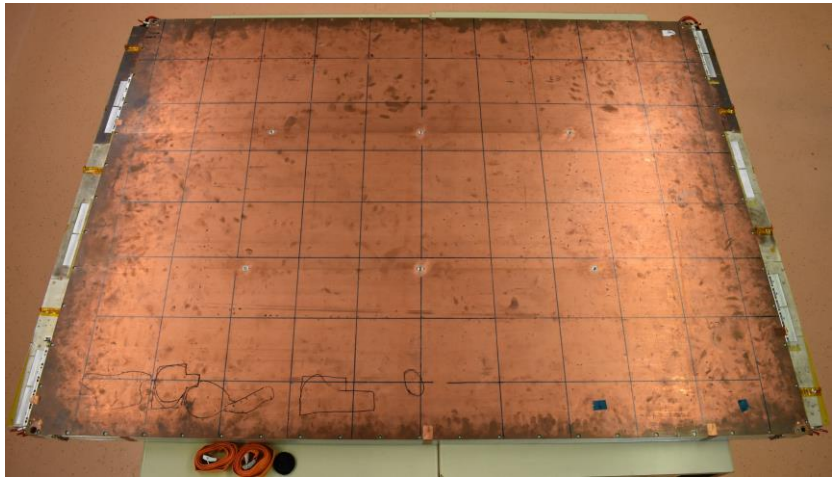
Gas gain study of a large-size multilayer Micromegas

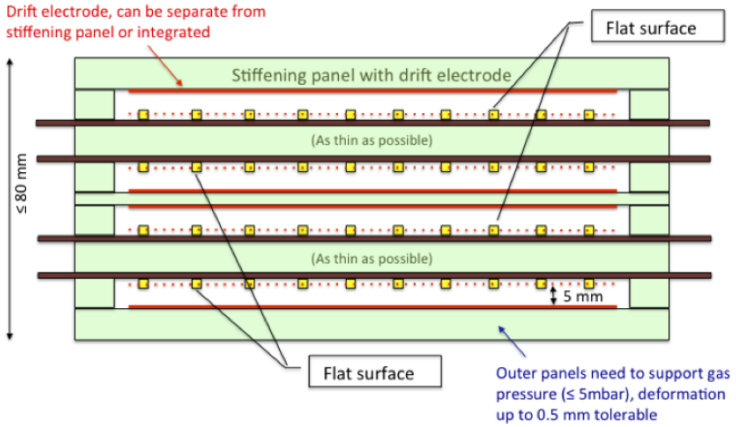
F. Dubinin, P. Iengo, G. Sekhniaidze, K. Zhukov

Introduction

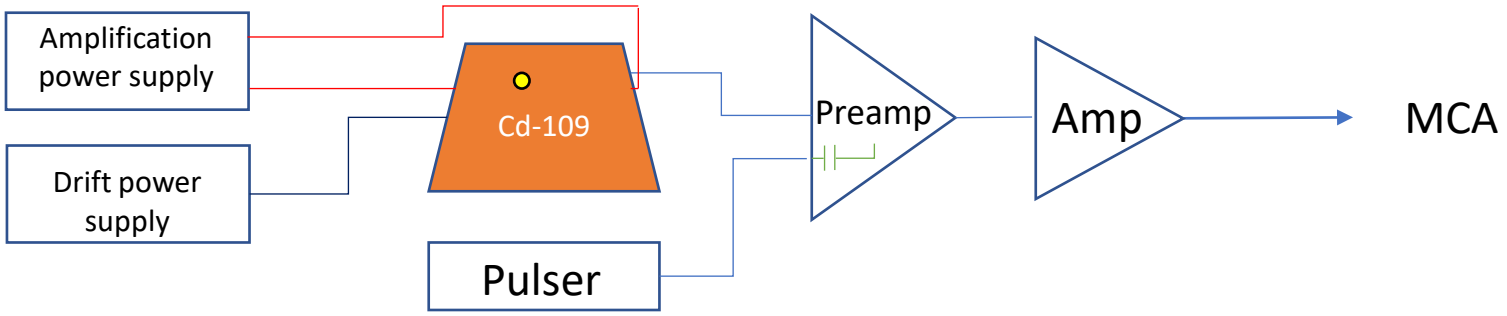


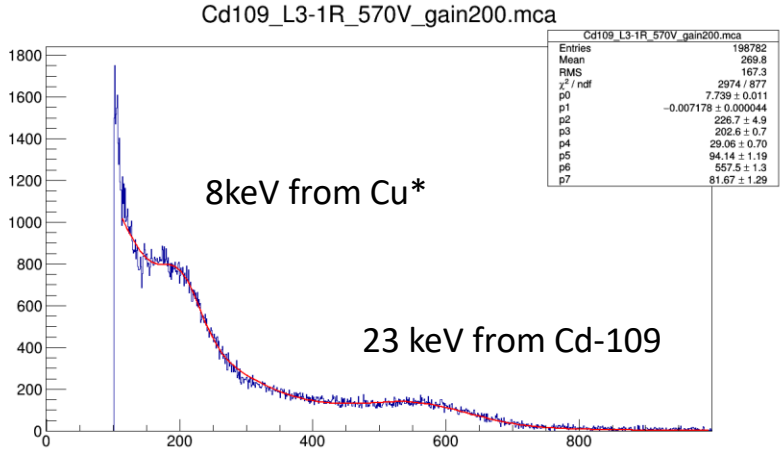
- 4 layers: two with horizontal strips, two with $\pm 1.5^0$ inclined strips
- 3 anode readout PCB per layer, 2 independent HV regions per PCB
- resistive anode strips creating amplification field
- 1024 readout copper strips per PCB with 425µm pitch
- micro-mesh and cathode compose drift pannel
- gas mixture: Ar/CO_2 (93%/7%)

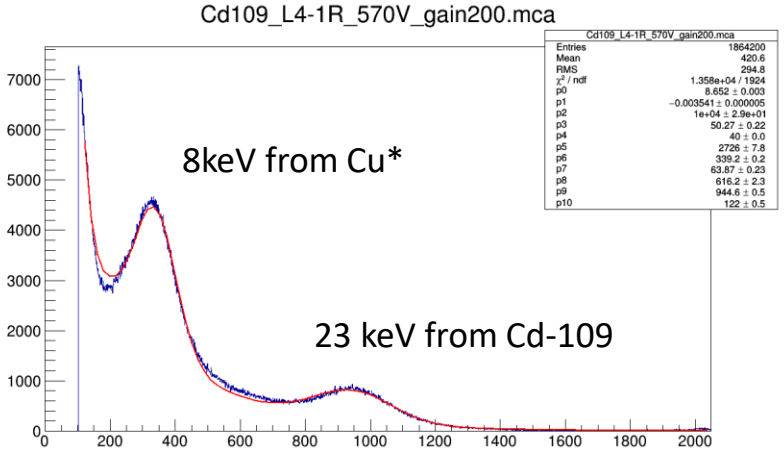




Experimental setup







Drift voltage scan

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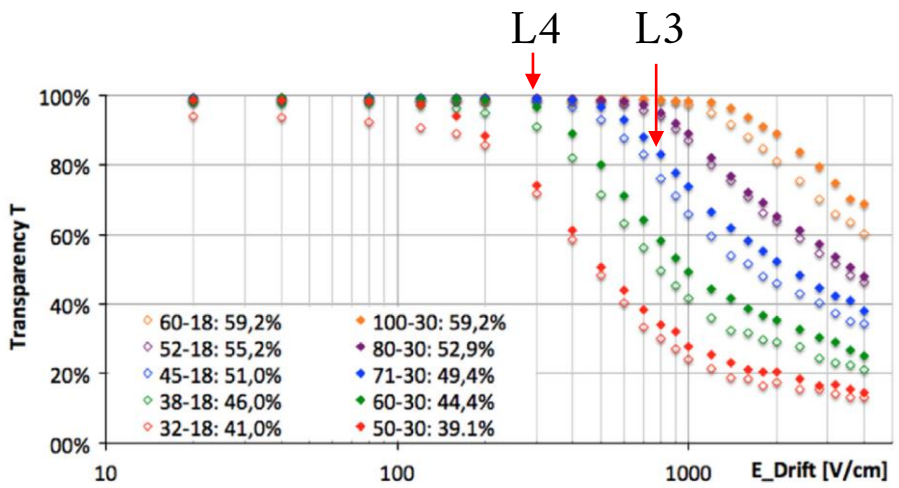
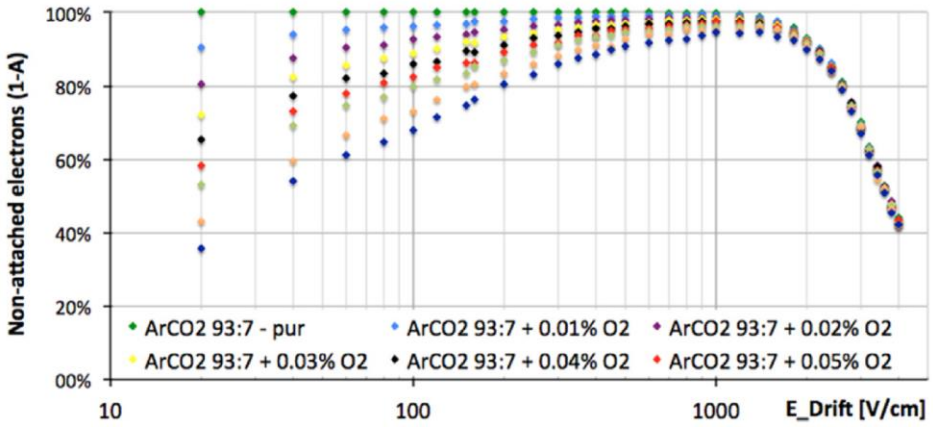
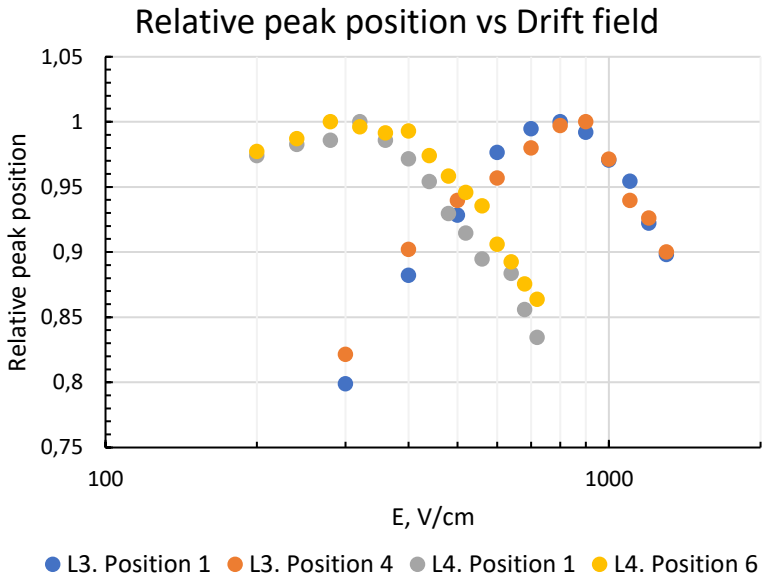






Max mesh transparency

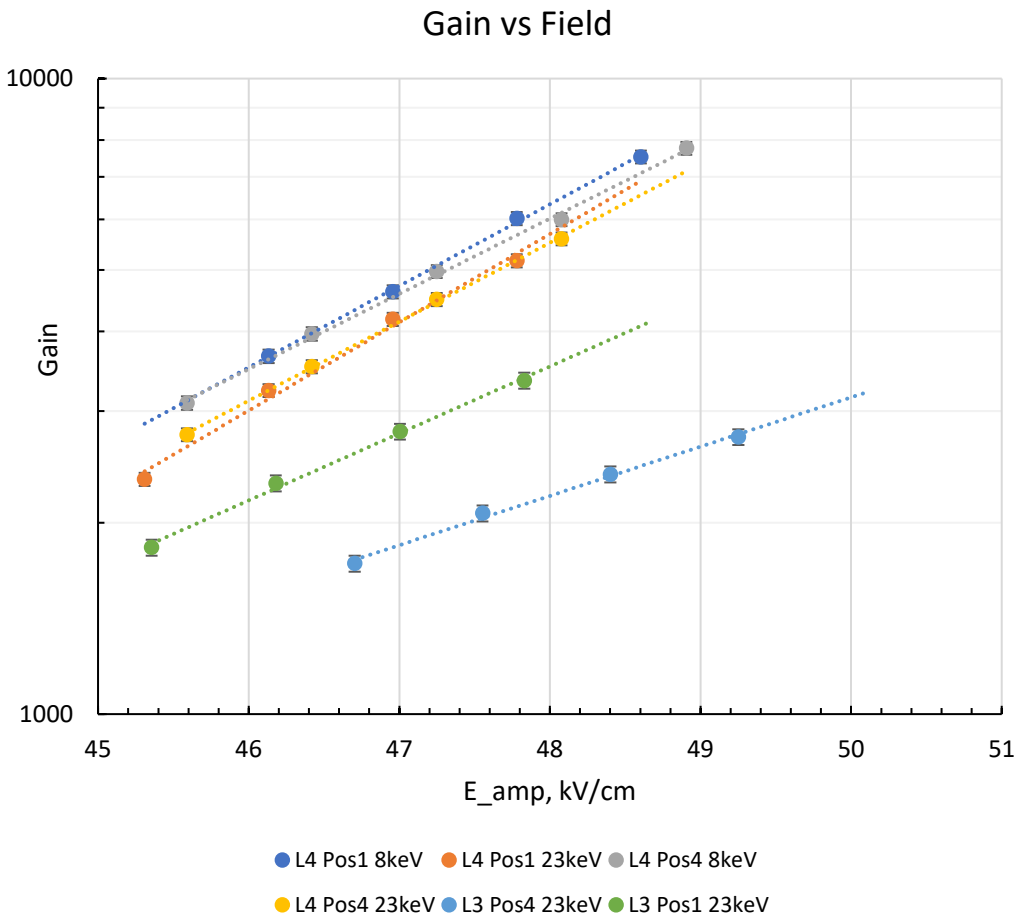
- Layer 3 = 85%
- Layer 4 = 99%

Primary electrons collection efficiency

- Layer 3 = 82%
- Layer 4 = 90%

Air contamination ~0.16%

Gas gain



- $E_{Cd-109} = 22.6\ keV$
- $E_{Cu^*} = 8.1\ keV$
- $\omega_{Ar(93\%)-CO_2(7\%)} = 26.49\ eV$
- $n_0 = \frac{E_\gamma}{\omega} \cdot \delta$

δ – primary electrons collection efficiency

- $G = \frac{Q}{n_0}$

Q – total charge calculated from photopeak position

- $E_{amp} = \frac{U_{amp}}{g}$

1st Townsend coefficient parametrization

$$\alpha = A_0 n \exp\left(-\frac{B_0 n}{E_{amp}}\right),$$

$$A_0 = k_B A,\ B_0 = k_B B.$$

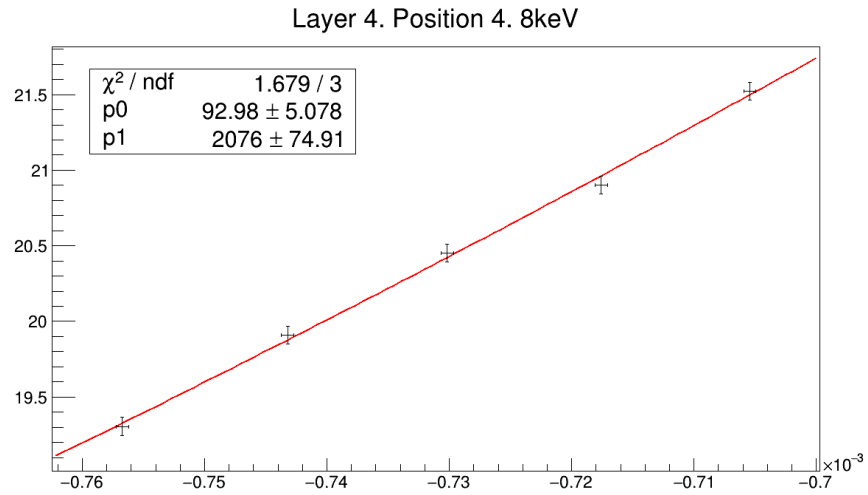
$$G = \exp\left(\frac{Apg}{T}\exp\left(-\frac{Bpg}{TV_{amp}}\right)\right).$$

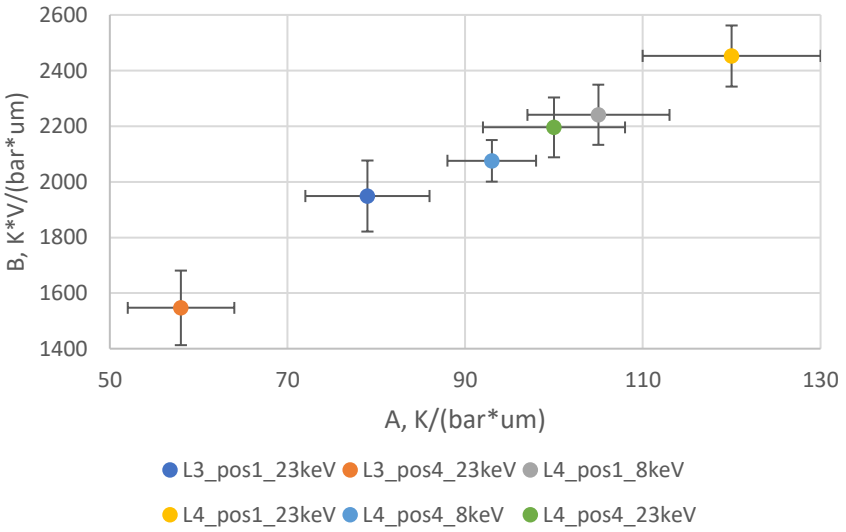
To extract the A and B parameters from the $G(V_{amp})$ dependence the expression was transformed to

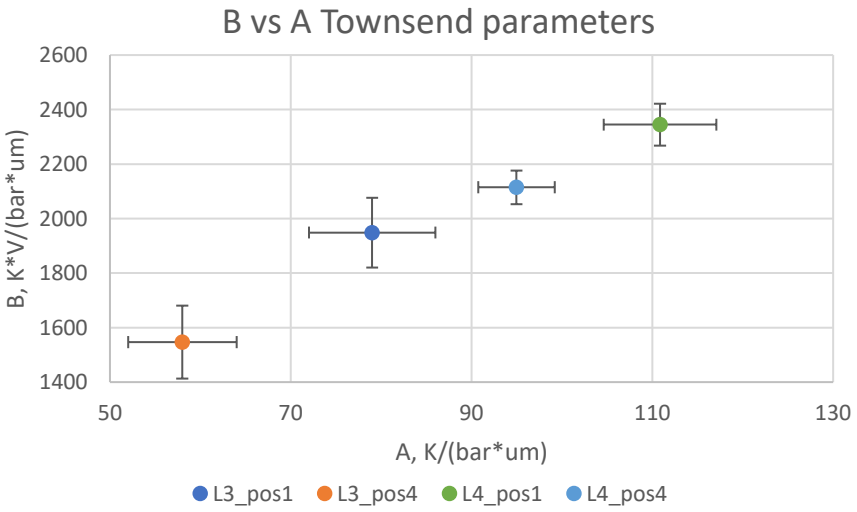
$$f = A\exp(Bx)$$

$$f = \frac{T}{Pg}\ln G,\ x = \frac{Pg}{TV_{amp}}.$$

Townsend coefficient parameters







$$A = (79 \pm 7)\frac{K}{bar \cdot \mu m}, \quad B = (1949 \pm 128)\frac{K \cdot V}{bar \cdot \mu m}$$

$$A = (58 \pm 6)\frac{K}{bar \cdot \mu m}, \quad B = (1547 \pm 134)\frac{K \cdot V}{bar \cdot \mu m}$$

$$A = (111 \pm 6)\frac{K}{bar \cdot \mu m}, \quad B = (2345 \pm 77)\frac{K \cdot V}{bar \cdot \mu m}$$

$$A = (95 \pm 4)\frac{K}{bar \cdot \mu m}, \quad B = (2115 \pm 62)\frac{K \cdot V}{bar \cdot \mu m}$$

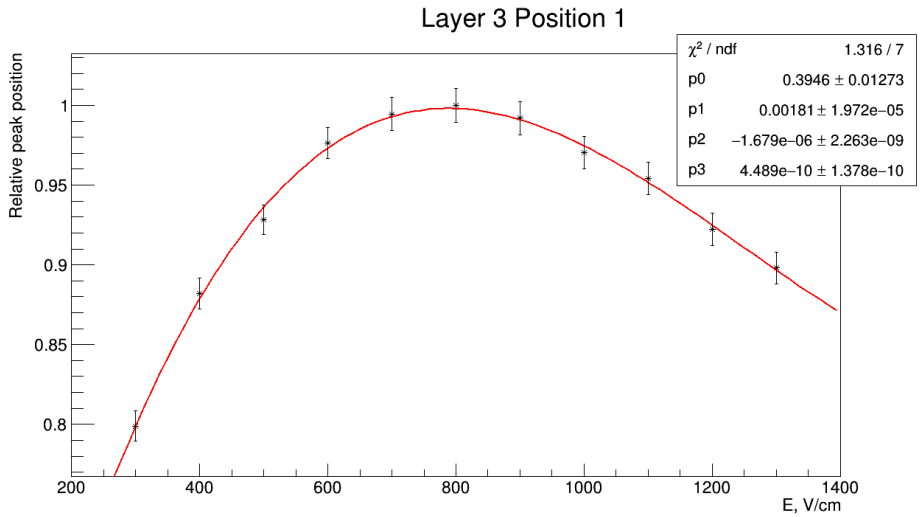
Conclusion

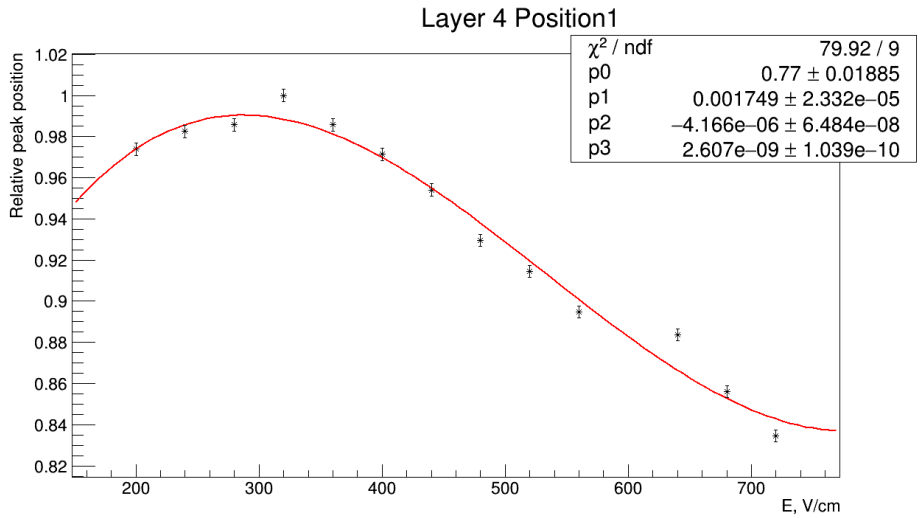
- Gas gain of 4 sectors of the large size Micromegas module was measured.
- 1st Townsend coefficient parameters were calculated.

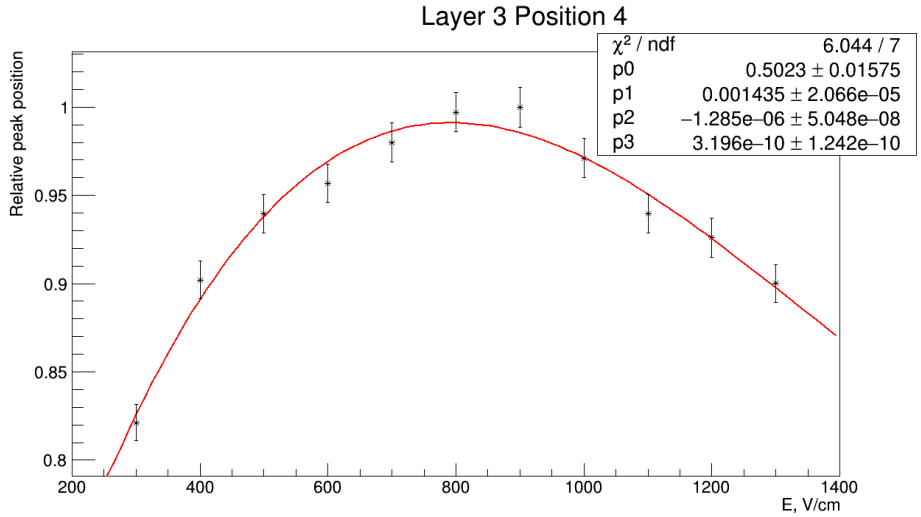
- Loss in primary electrons and low gain were observed at the layer 3. The cause was found to be gas leak at layer 3 at left side of the module.
- Oxygen contamination from primary electrons collection curves is estimated to be ~0.16%.

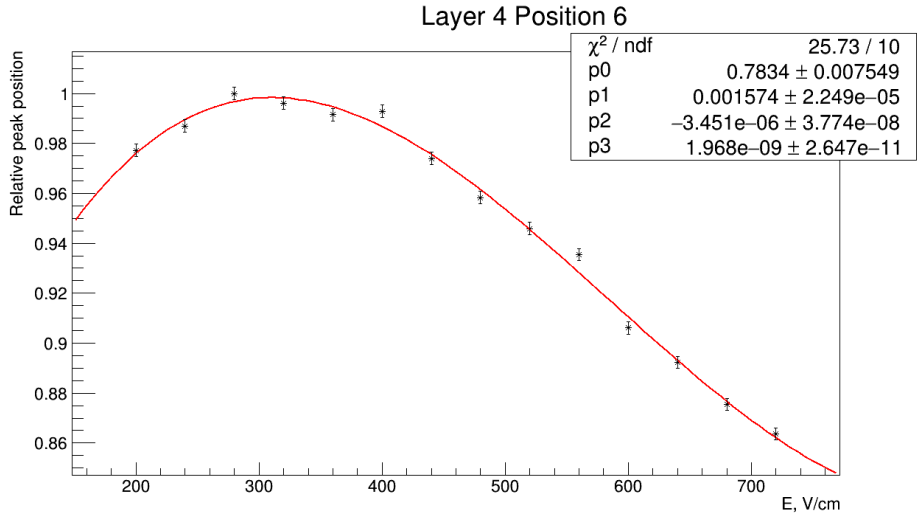
Thank you!

Drift scan


Layer 3 Position 1
χ² / ndf 1.316 / 7
p0 0.3946 ± 0.01273
p1 0.00181 ± 1.972e−05
p2 −1.679e−06 ± 2.263e−09
p3 4.489e−10 ± 1.378e−10
Relative peak position
E, V/cm


Layer 4 Position1
χ² / ndf 79.92 / 9
p0 0.77 ± 0.01885
p1 0.001749 ± 2.332e−05
p2 −4.166e−06 ± 6.484e−08
p3 2.607e−09 ± 1.039e−10
Relative peak position
E, V/cm


Layer 3 Position 4
χ² / ndf 6.044 / 7
p0 0.5023 ± 0.01575
p1 0.001435 ± 2.066e−05
p2 −1.285e−06 ± 5.048e−08
p3 3.196e−10 ± 1.242e−10
Relative peak position
E, V/cm


Layer 4 Position 6
χ² / ndf 25.73 / 10
p0 0.7834 ± 0.007549
p1 0.001574 ± 2.249e−05
p2 −3.451e−06 ± 3.774e−08
p3 1.968e−09 ± 2.647e−11
Relative peak position
E, V/cm

1st Townsend coefficient parametrization

$$G = \frac{n}{n_0} = \exp(\alpha g),$$

- α – 1st Townsend coefficient,
- g – amplification gap

$$\alpha = A_0 n \exp\left(-\frac{B_0 n}{E_{amp}}\right),$$

- $A_0 = k_B A,\ B_0 = k_B B$
- $n = \frac{p}{k_B T}$ - density of the gas

$$G = \exp\left(\frac{Apg}{T}\exp\left(-\frac{Bpg}{TV_{amp}}\right)\right),$$

- $V_{amp} = E_{amp} g$ – Amplification voltage

Townsend coefficient parameters