Charge Distribution dependency on gap thickness of CMS endcap RPC

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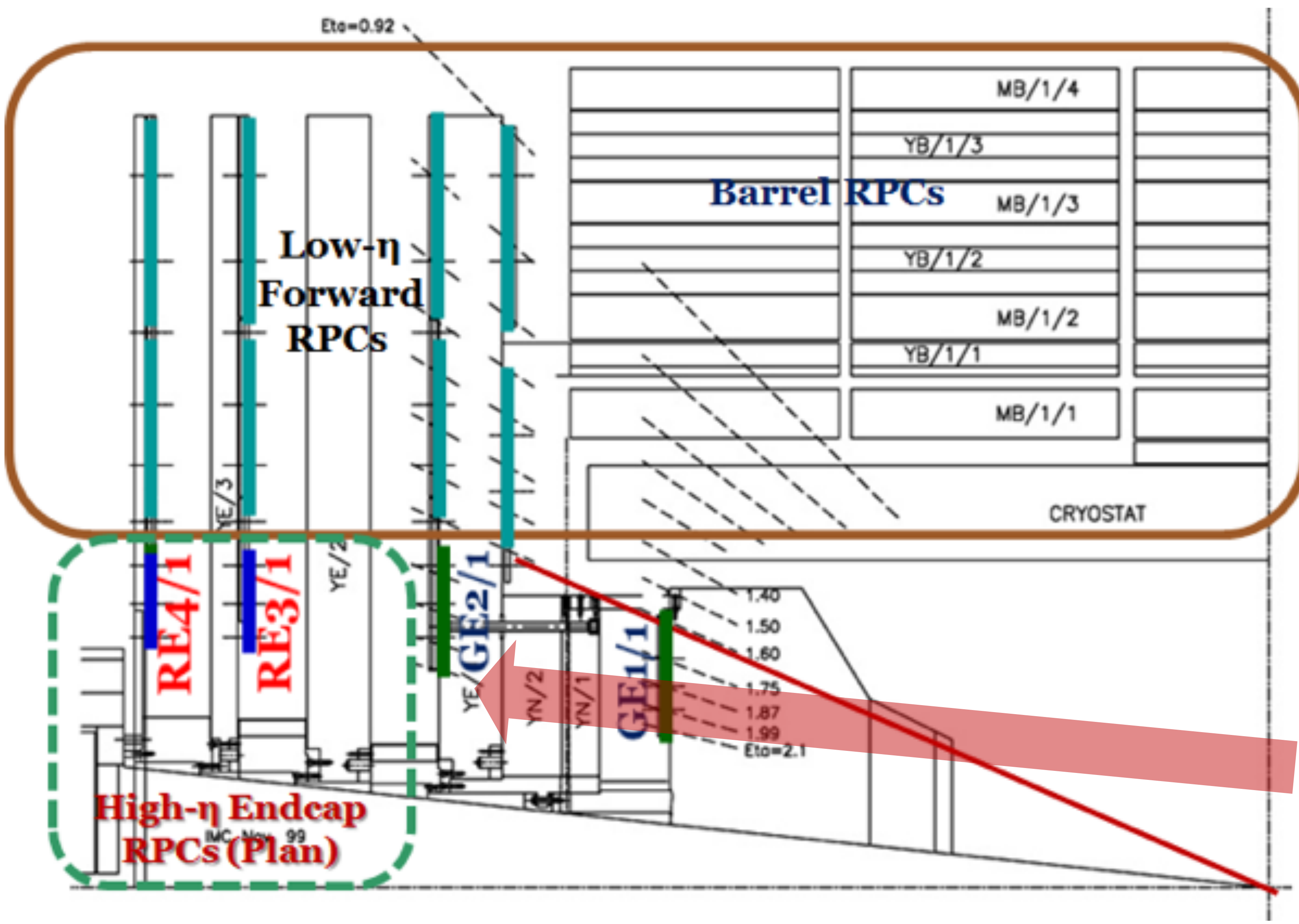
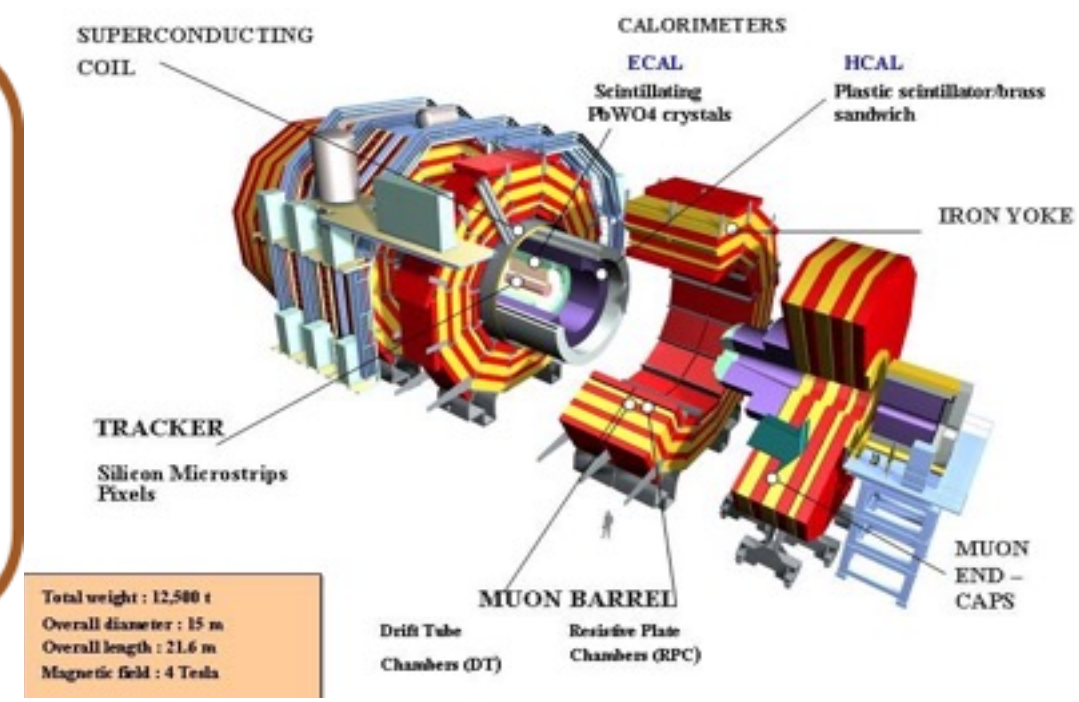
On behalf of the CMS RPC group

1. Motivation
2. Measurement of charges in 6 different gap thickness
3. Conclusion

The present detector R&D is for future CMS RPCs at high backgrounds

✓ In PHASE II upscope, we need new endcap RPCs in $1.6 < |\eta| < 2.1(2.4)$ by 2023.





RPCs in high-η to be developed in the phase II

Direction of R & Ds for high-η CMS RPCs (at RE3/1 and RE4/1)

Higher rate capability can be achieved if

- ✓ Lower resistivity of electrode→ Rate capability ~ 1/ ρ
- ✓ Use smaller avalanche charges with a lower digitization threshold
  - → Better for reducing the probability of aging due to high-rate background
  - → To guarantee the longevity of the RPC gaps

For threshold dependency with large size chambers (Kyongsei's talk)

1) Double gap with 1.6mm gas gap thickness
2) Multigap 4 gaps with 0.8mm gas gap thickness

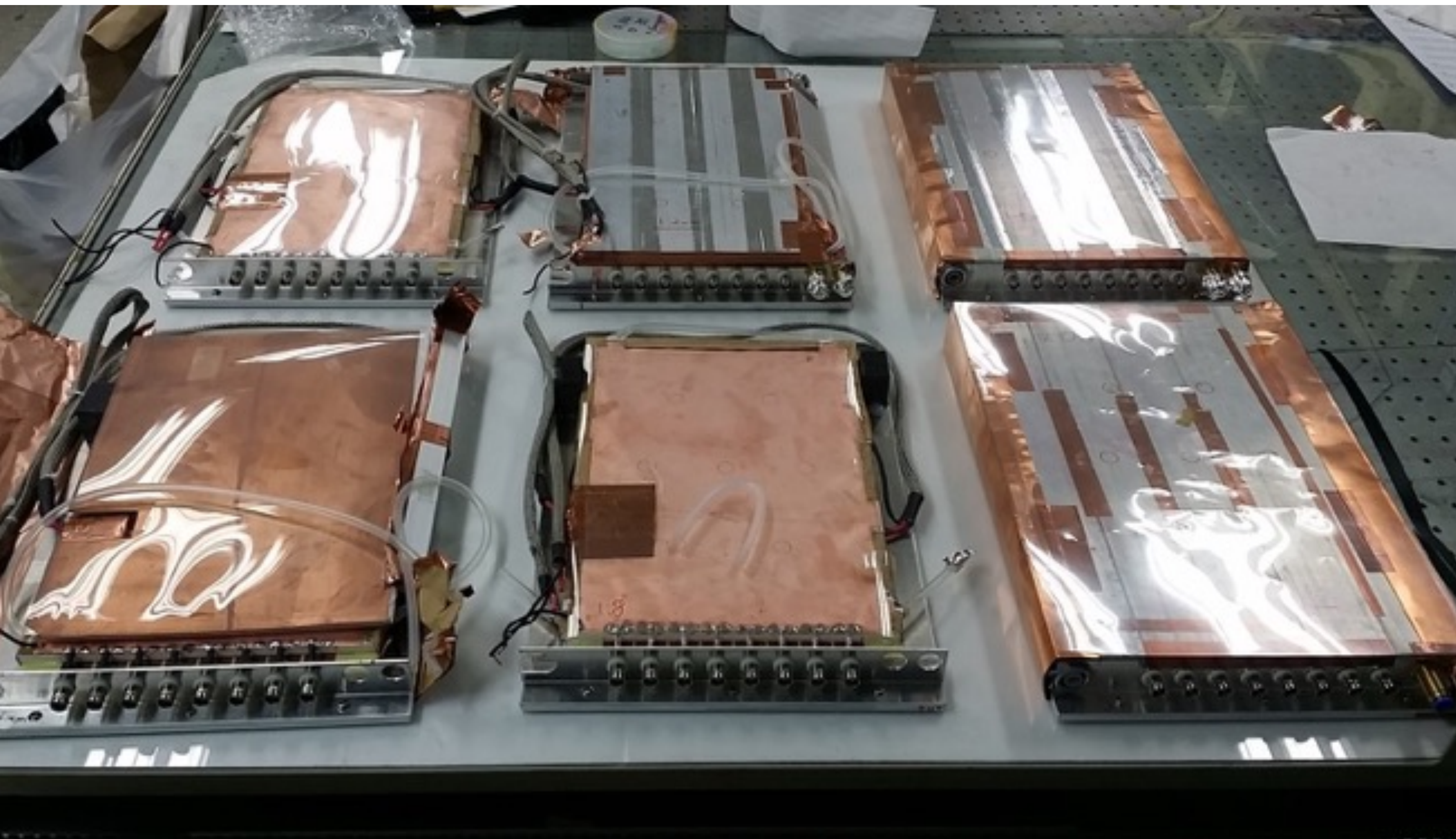
For charge dependency with small size chambers:

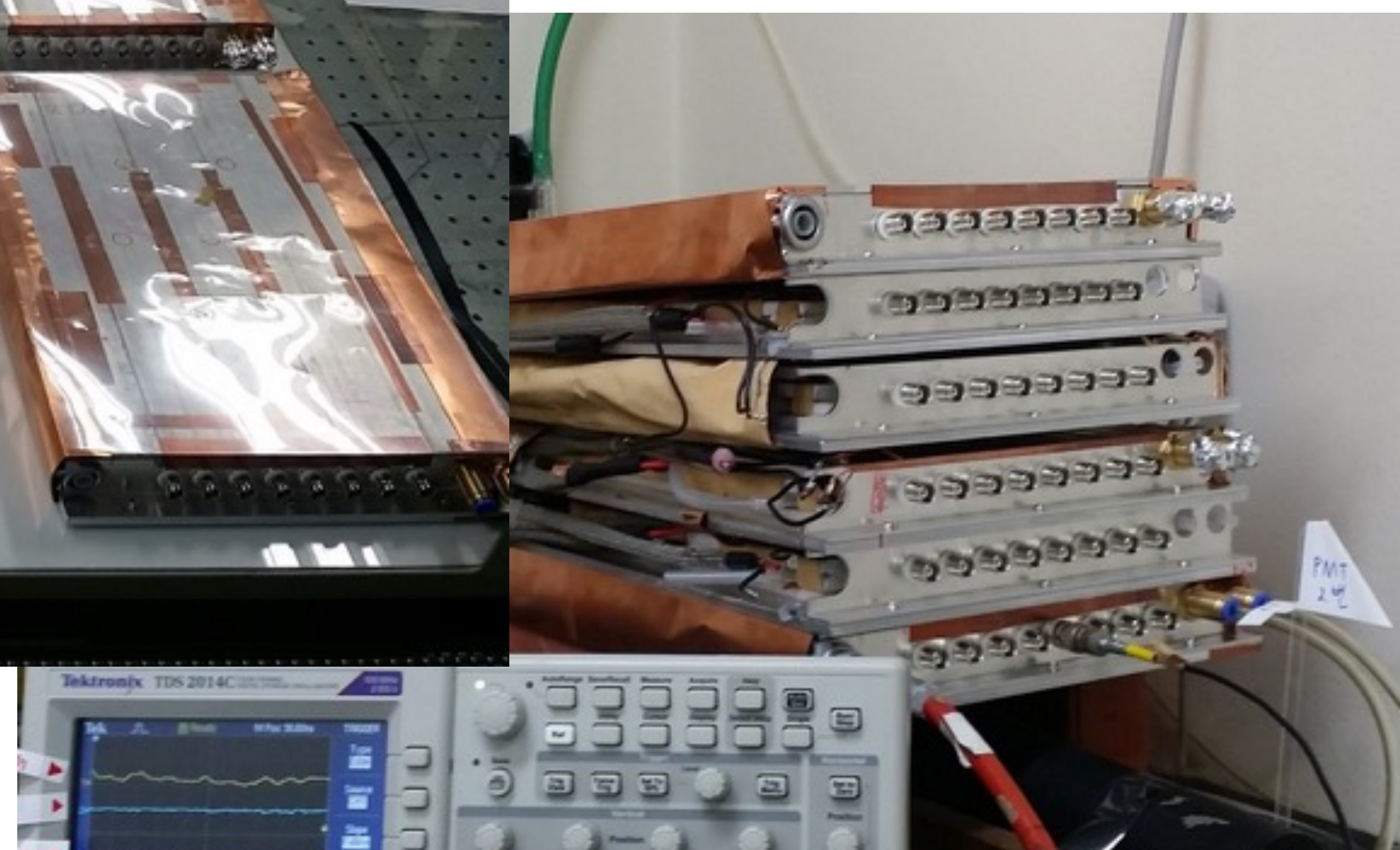
1) Six double gaps with 0.2mm steps from 2.0mm to 1.0mm

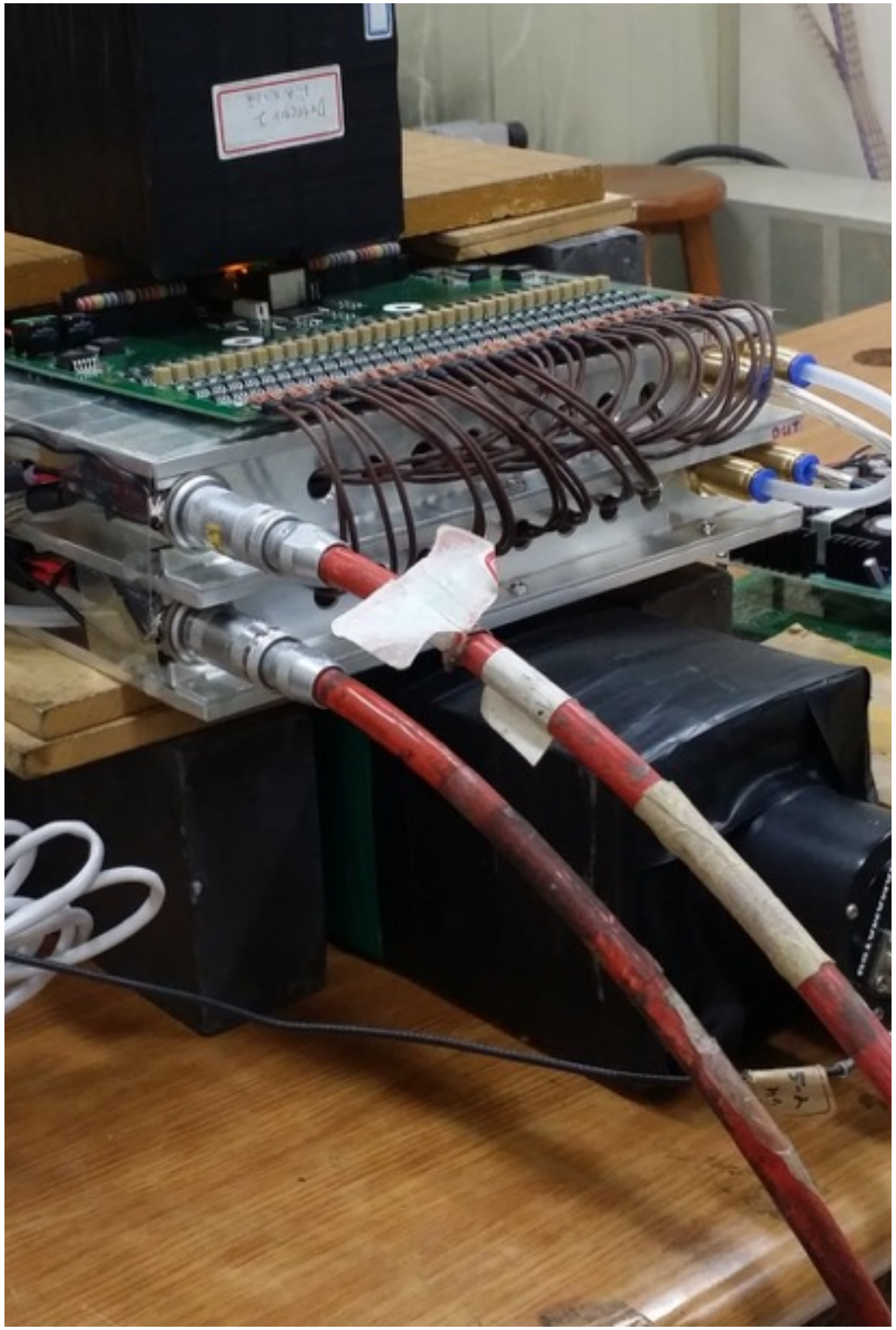
Six RPCs at KODEL

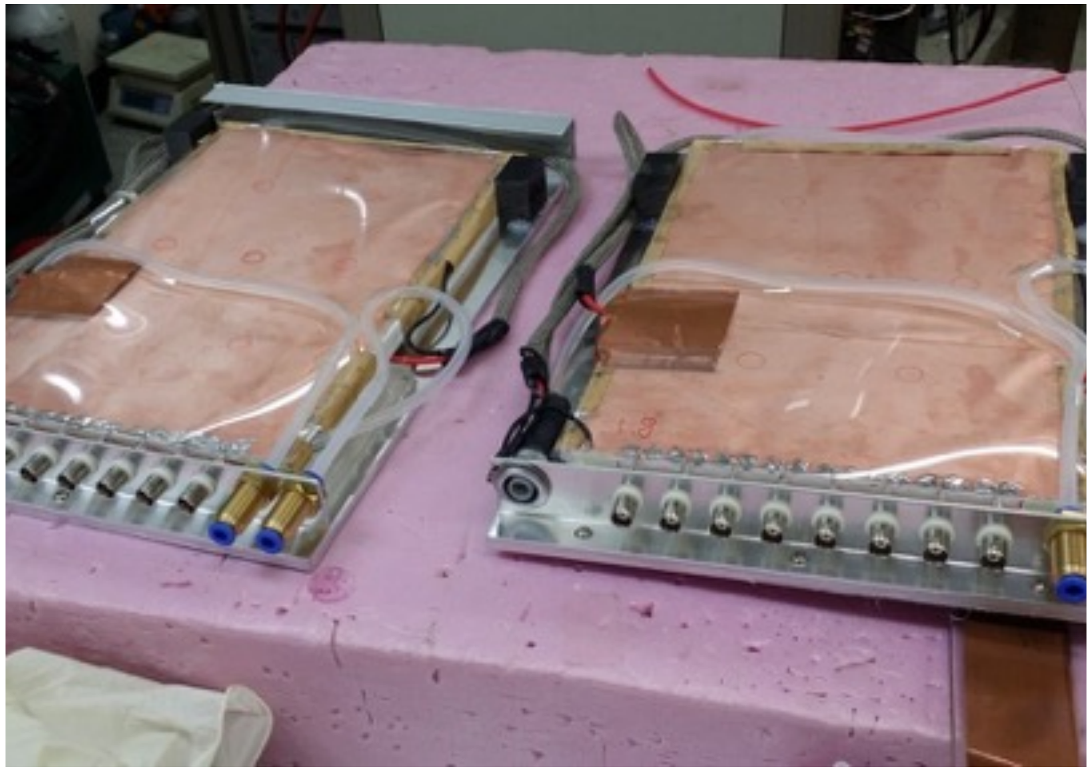
Six RPCs with different gap thickness:

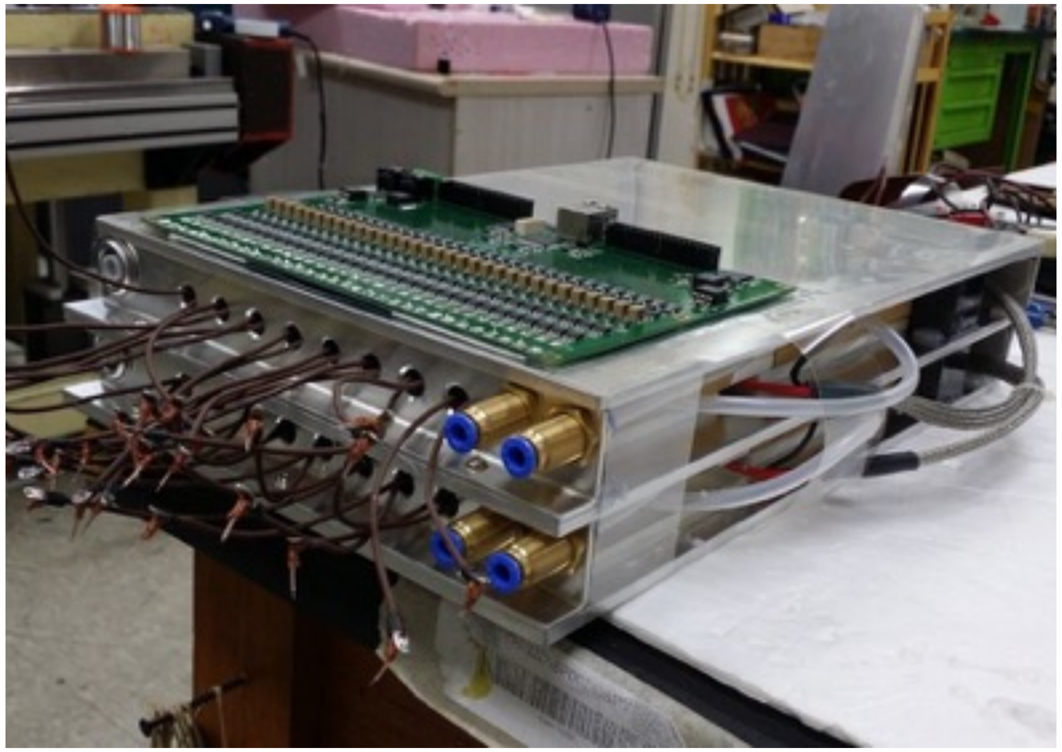
1.0, 1.2, 1.4, 1.6, 1.8, 2.0 mm











Operation of 6 Gaps

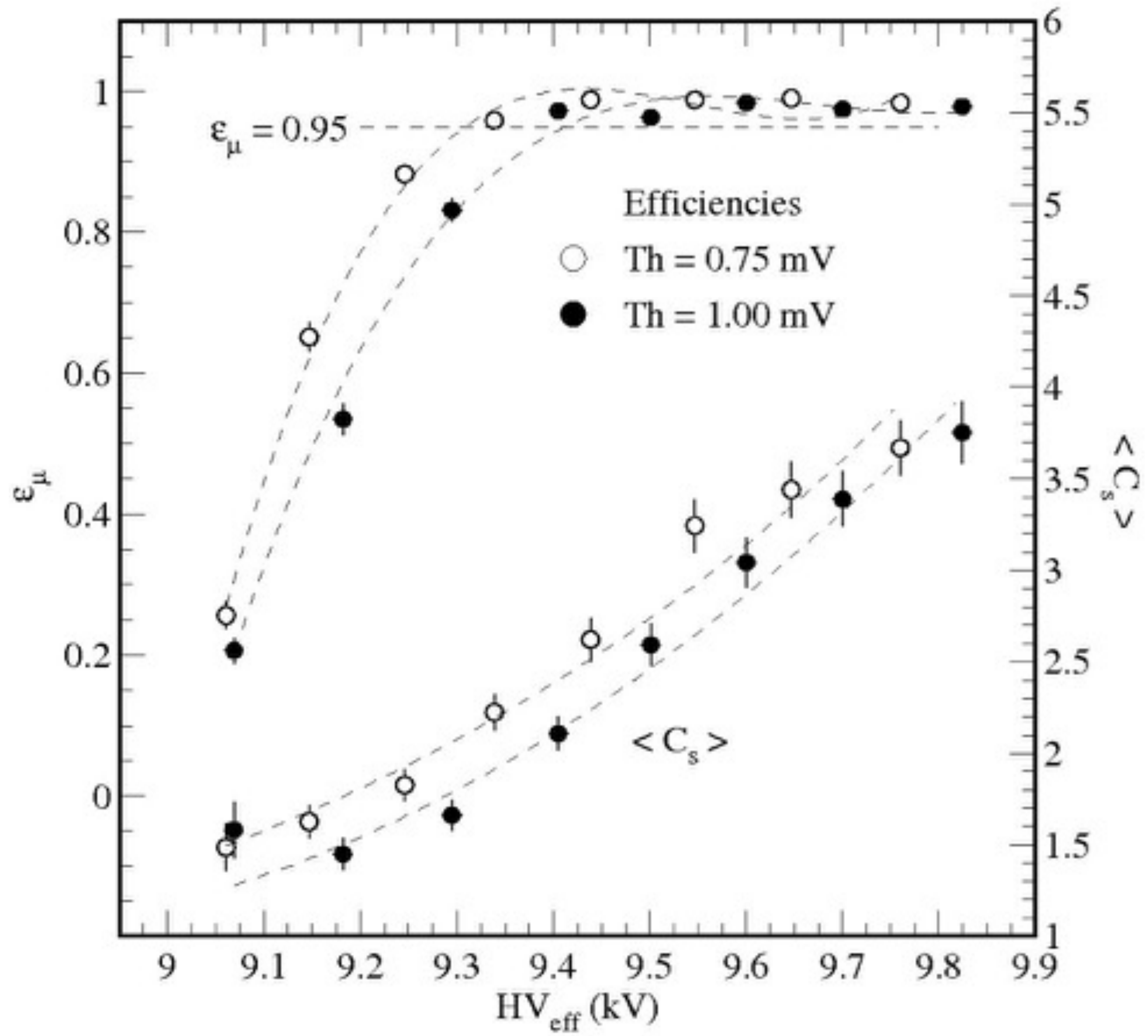
1 Efficiency & Cluster size of each gap thickness

2 H.V & E-field vs. gap thickness

3 Charge distribution of each gap thickness

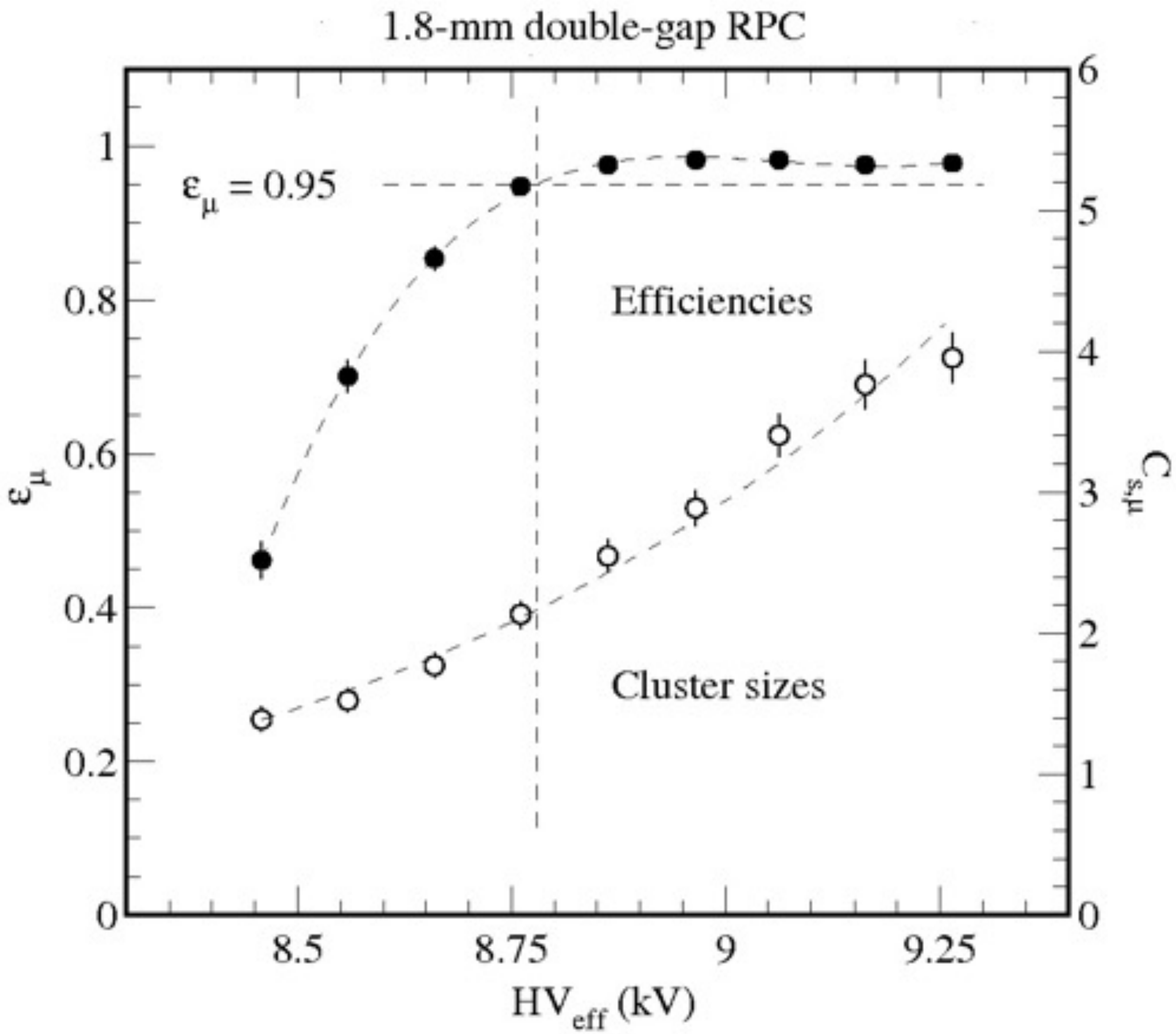
4 Models for charge distributions

Efficiency in 2.0mm



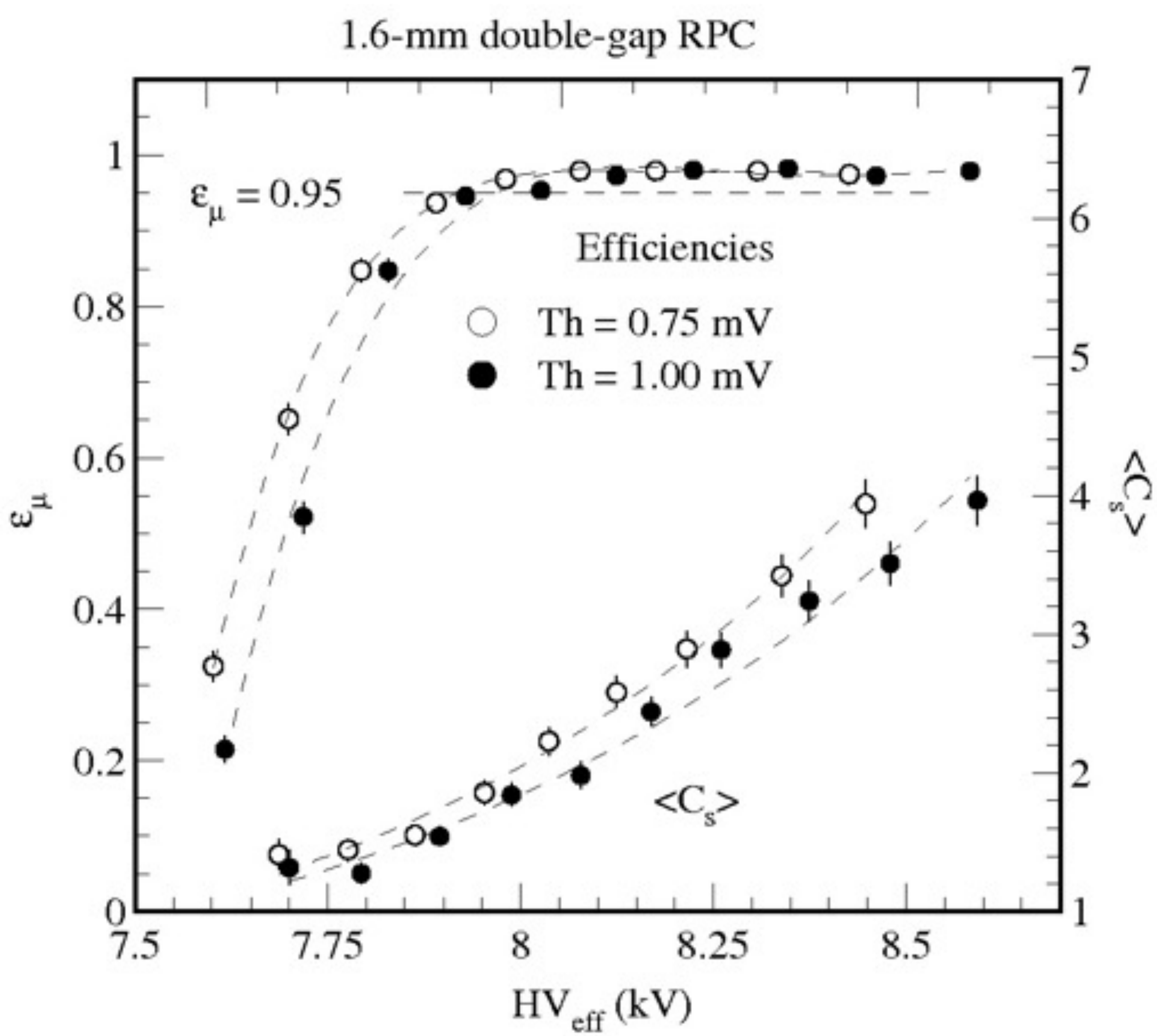
	H.V(kV)
Eff 50%	9.17
Eff>95%	9.39

Efficiency in 1.8mm



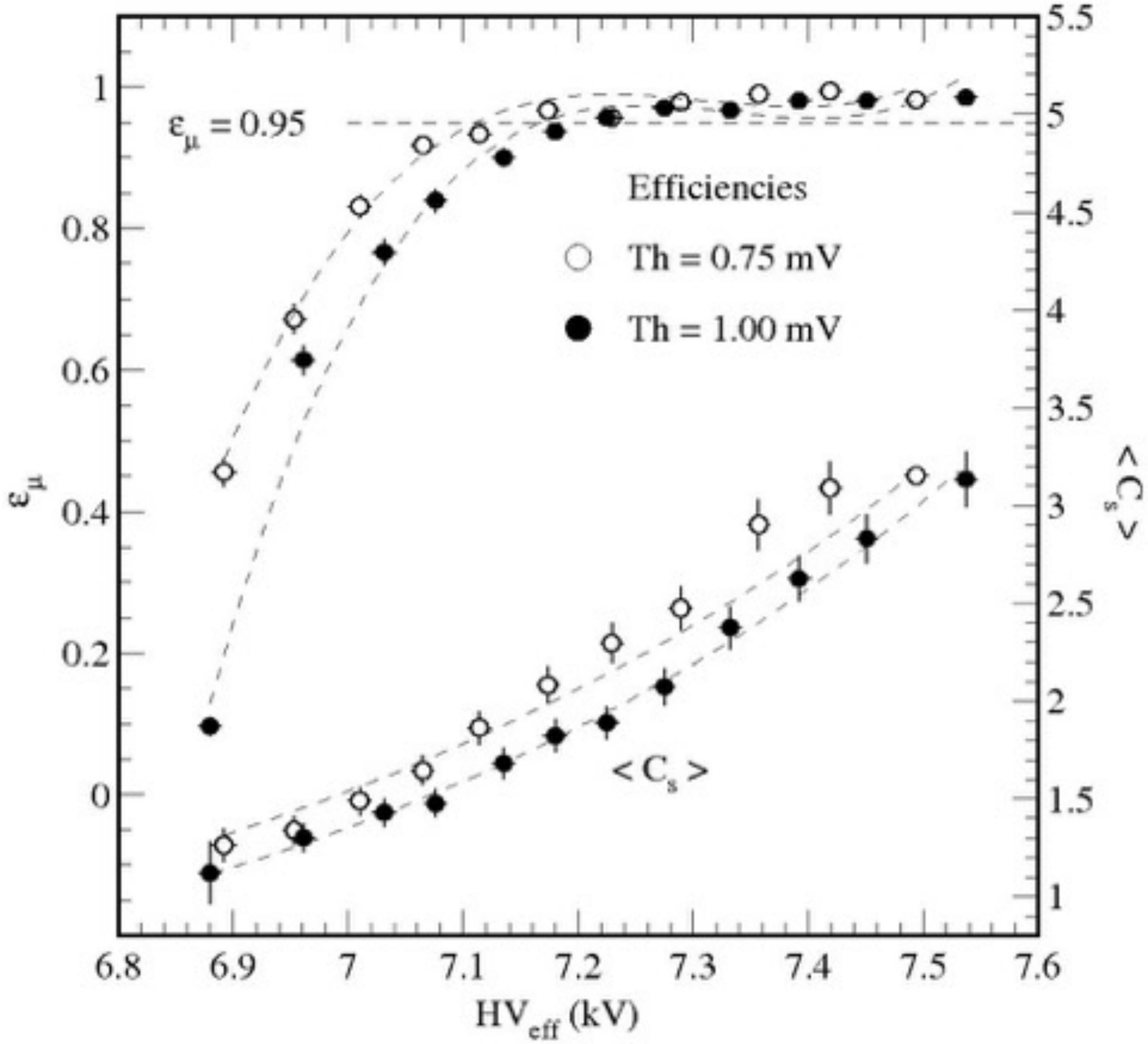
	H.V(kV)
Eff 50%	8.47
Eff>95%	8.78

Efficiency in 1.6mm



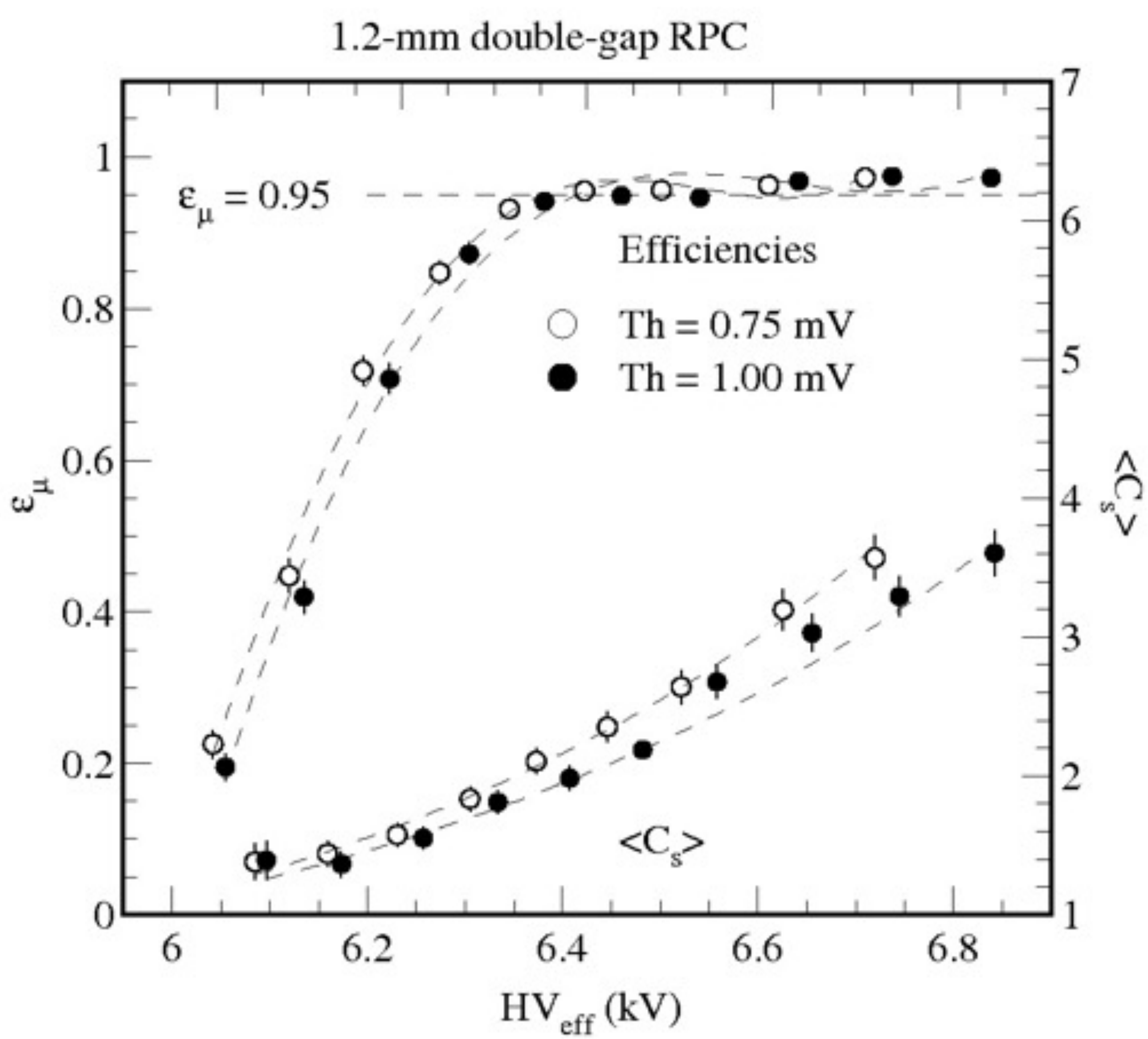
	H.V(kV)
Eff 50%	7.71
Eff>95%	7.99

Efficiency in 1.4mm



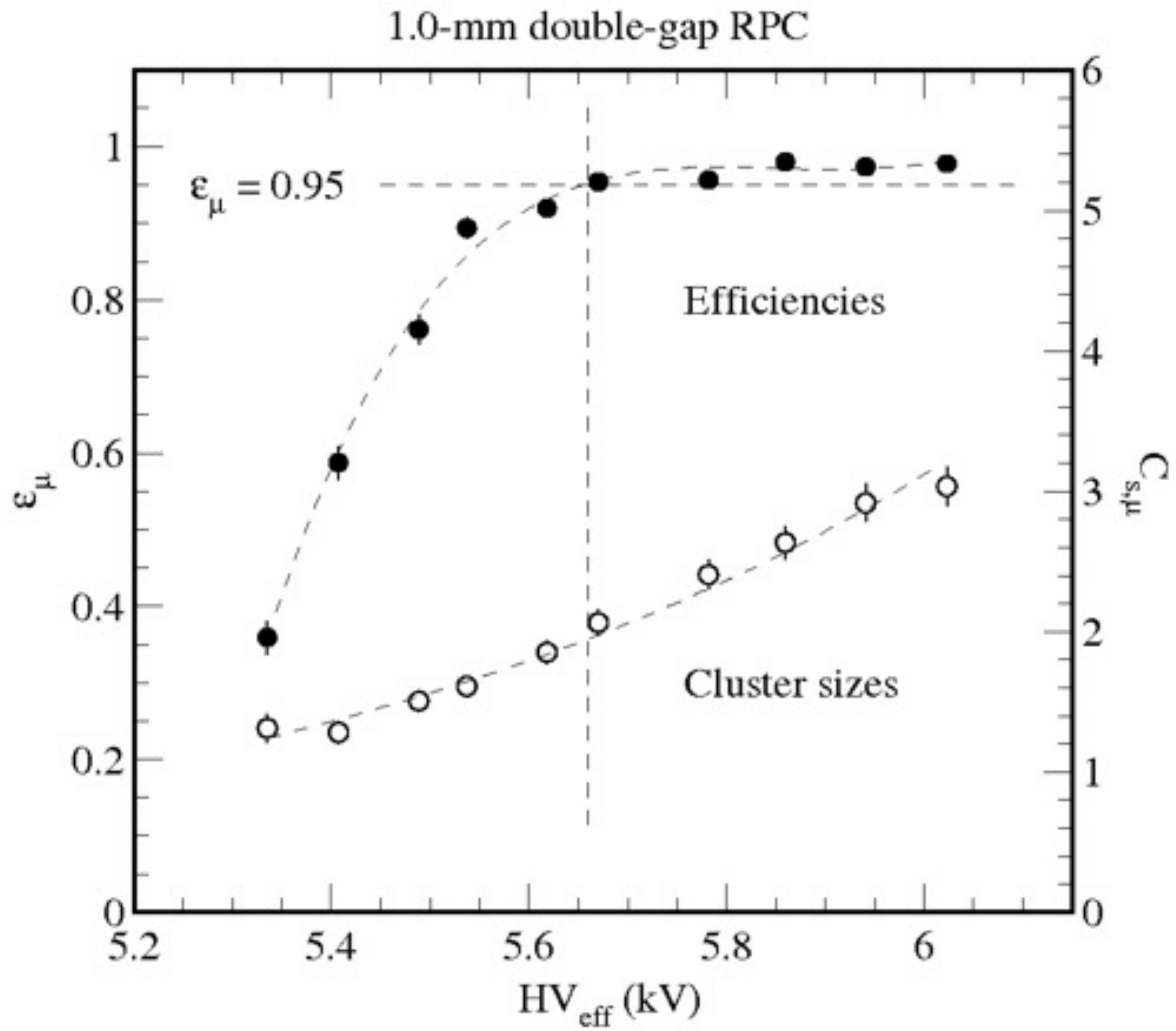
	H.V(kV)
Eff 50%	6.94
Eff>95%	7.21

Efficiency in 1.2mm



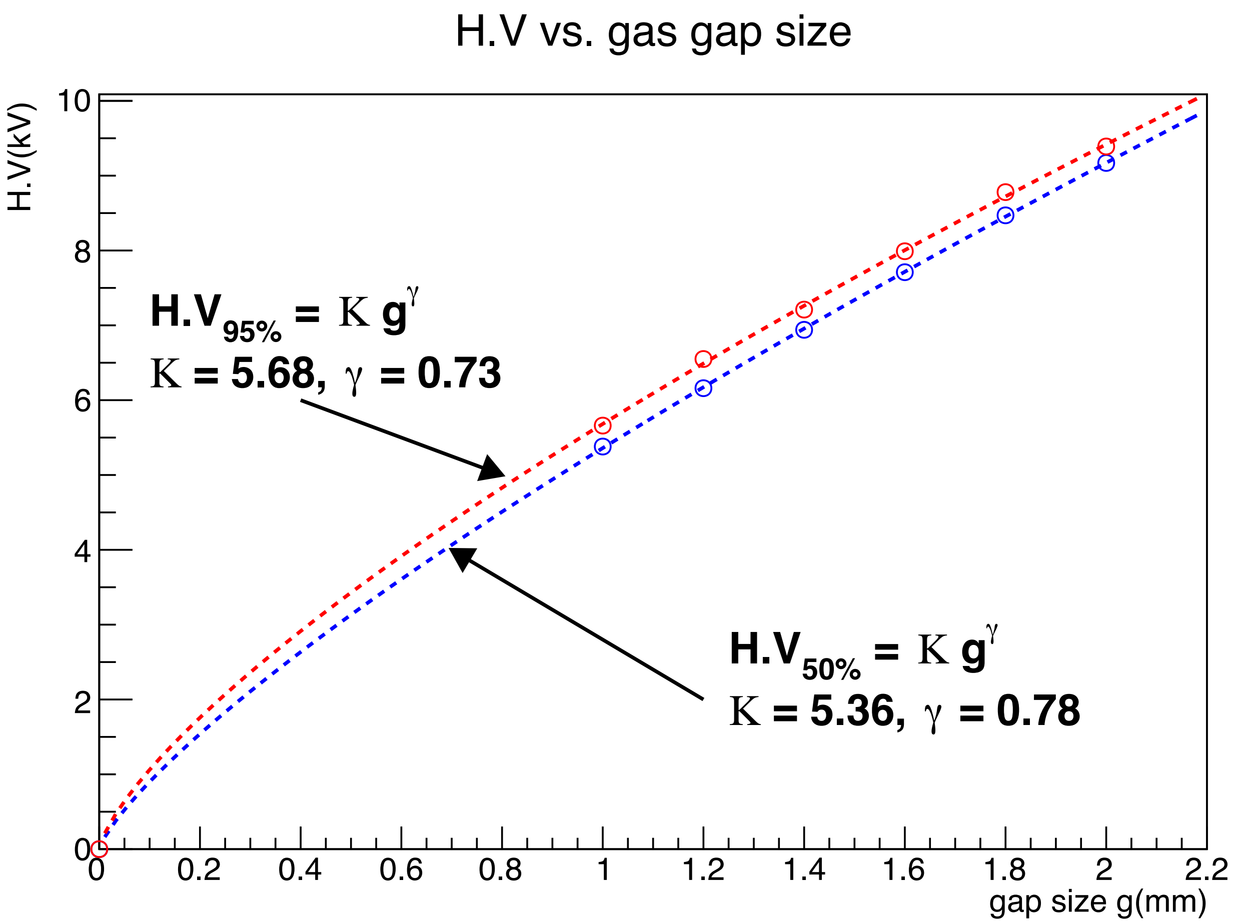
	H.V(kV)
Eff 50%	6.16
Eff>95%	6.50

Efficiency in 1.0mm



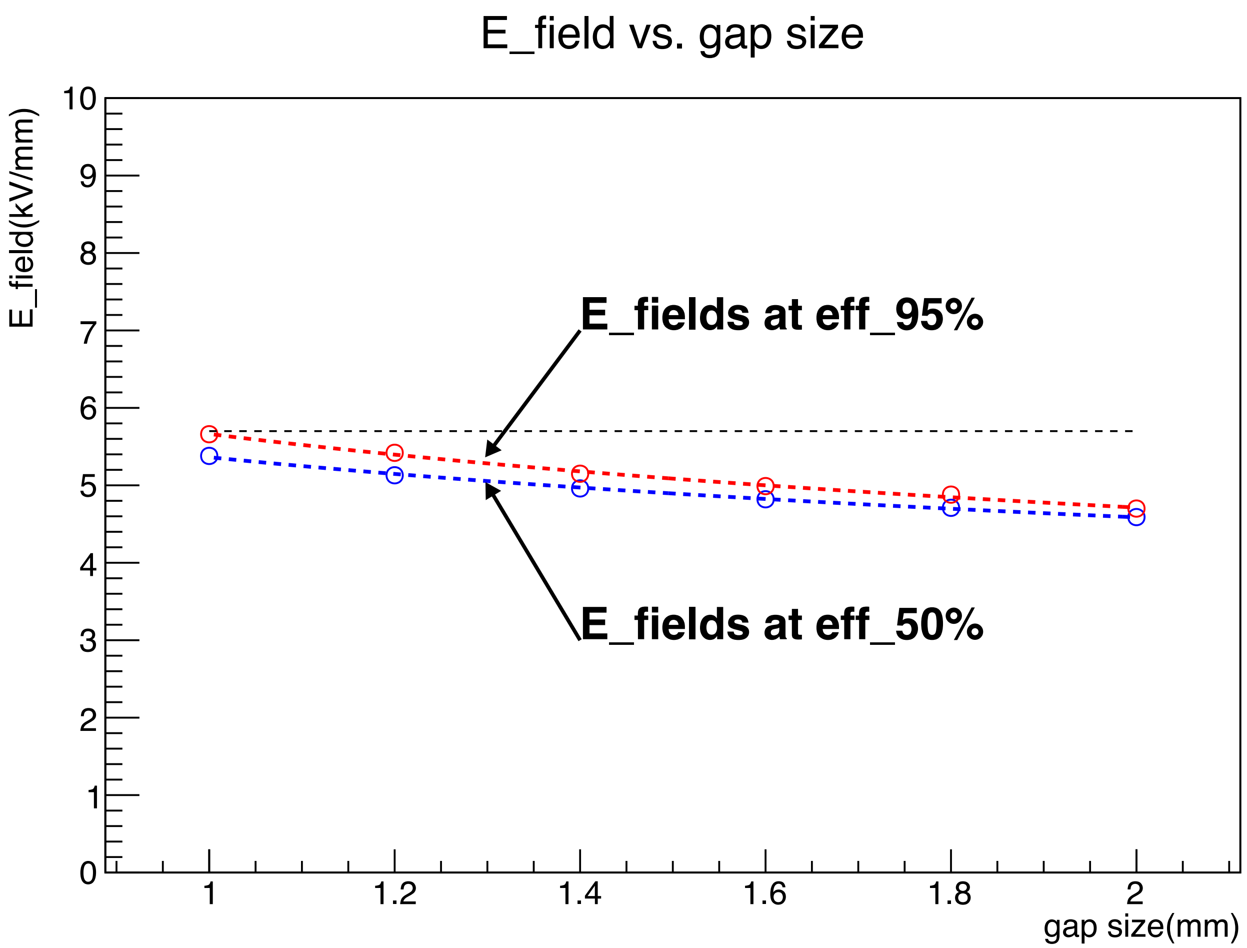
	H.V(kV)
Eff 50%	5.38
Eff>95%	5.66

H.V vs. gap size



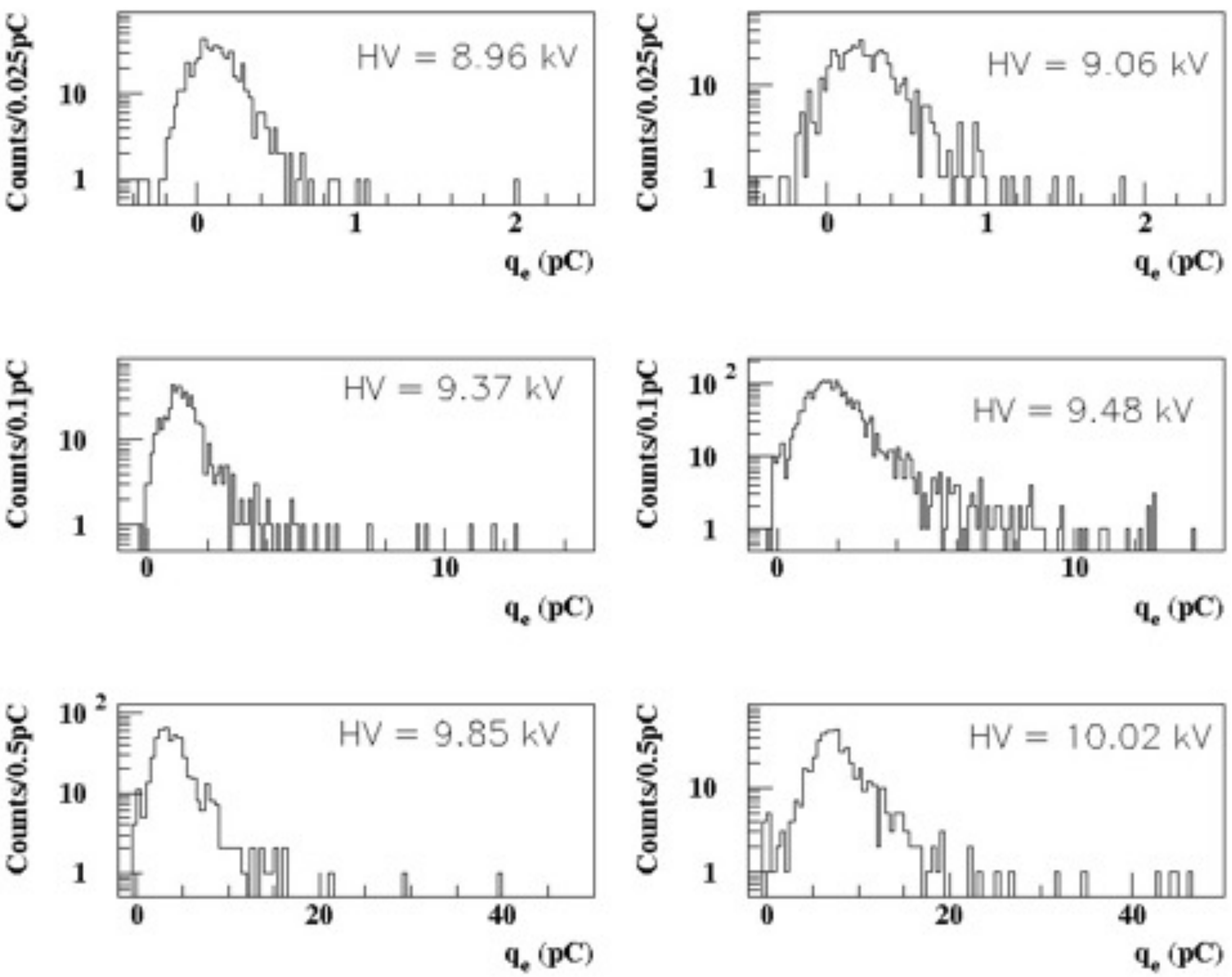
gap(mm)	H.V_50%(kV)	H.V_95%(kV)
1.0	5.38	5.66
1.2	6.16	6.50
1.4	6.94	7.21
1.6	7.71	7.99
1.8	8.47	8.78
2.0	9.17	9.39

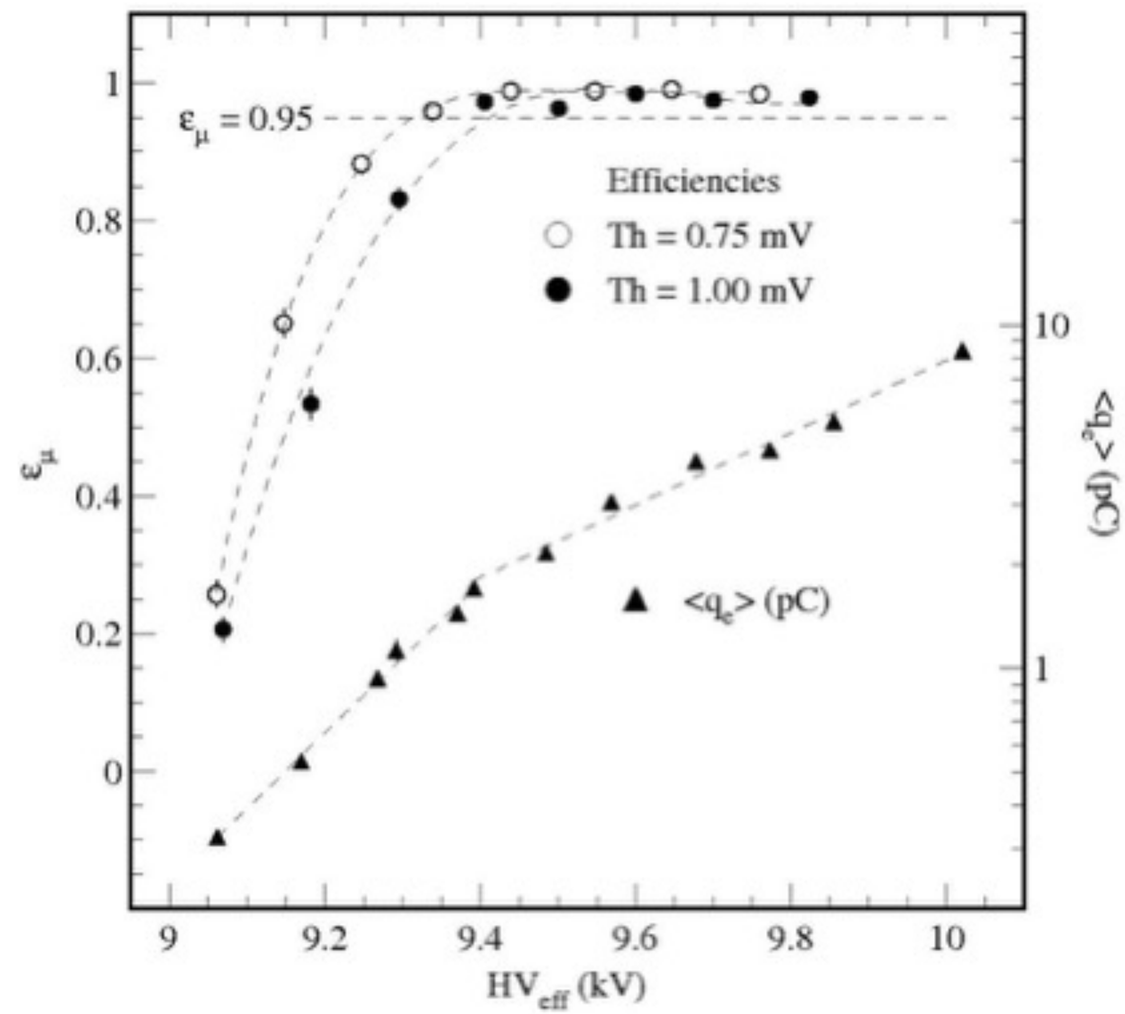
E_field vs. gap size



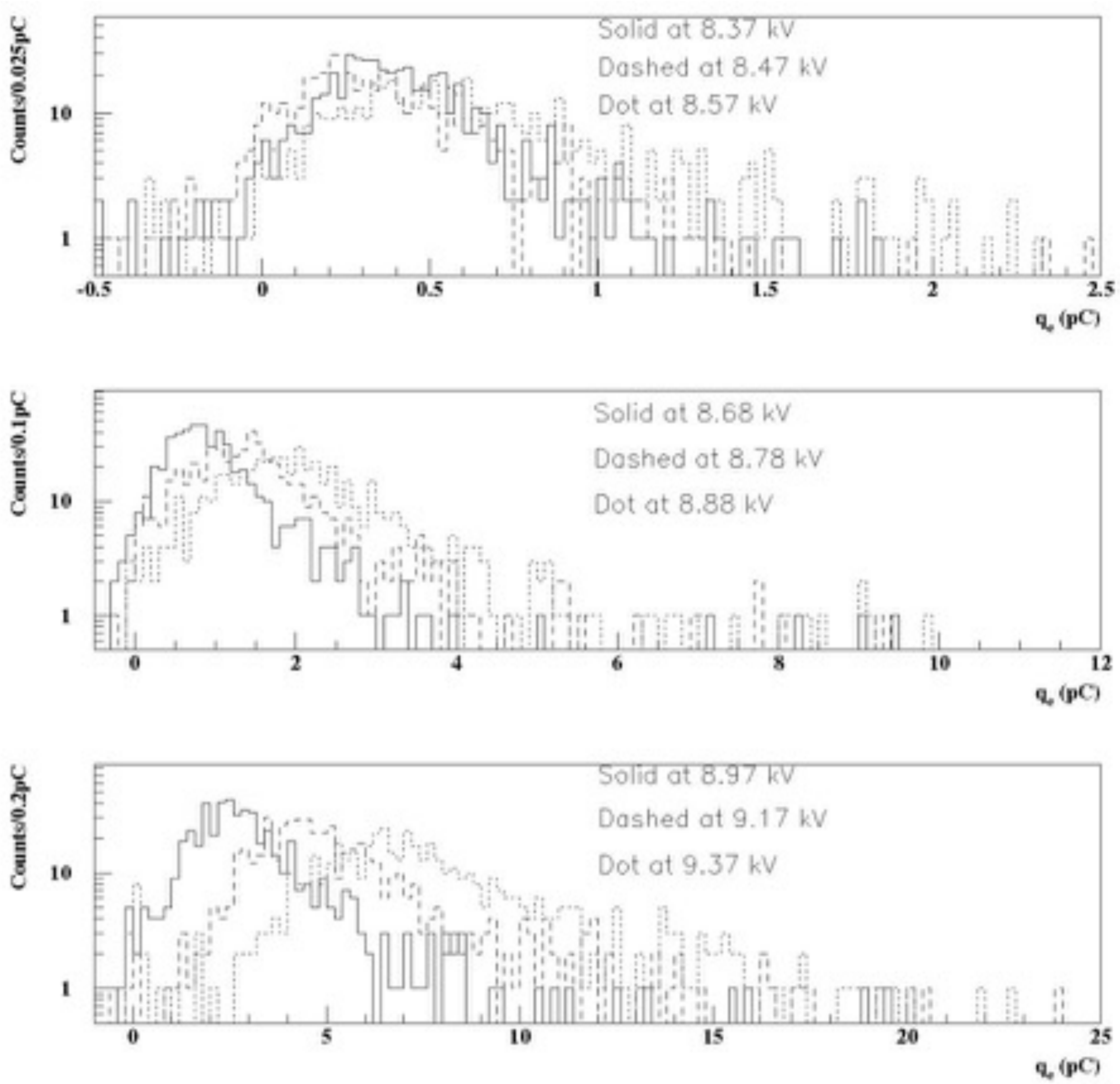
gap(mm)	E_fields@50% (kV/mm)	E_fields@95% (kV/mm)
1.0	5.38	5.66
1.2	5.13	5.42
1.4	4.96	5.15
1.6	4.82	4.99
1.8	4.71	4.88
2.0	4.59	4.70

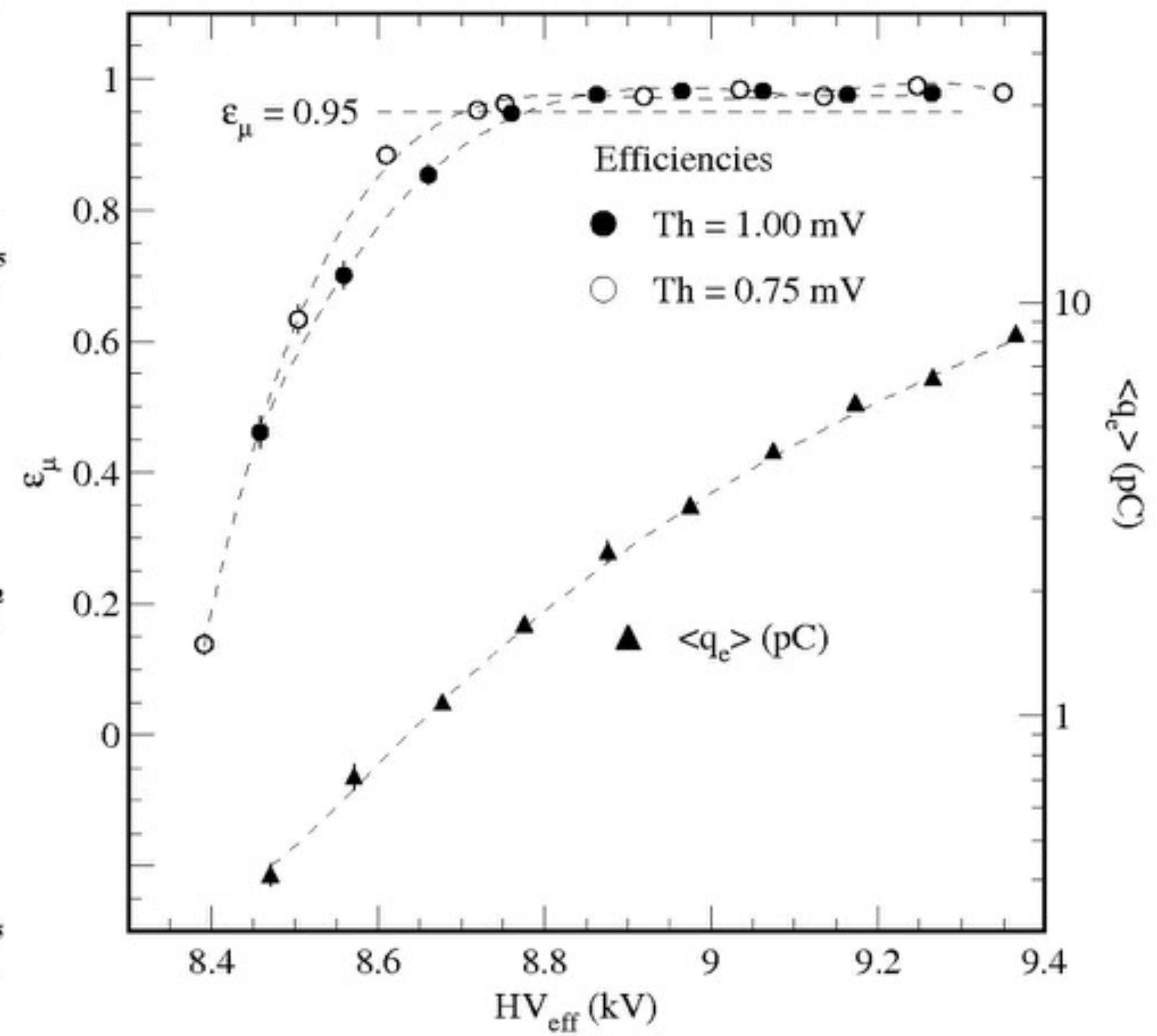
Charge distribution in 2.0mm



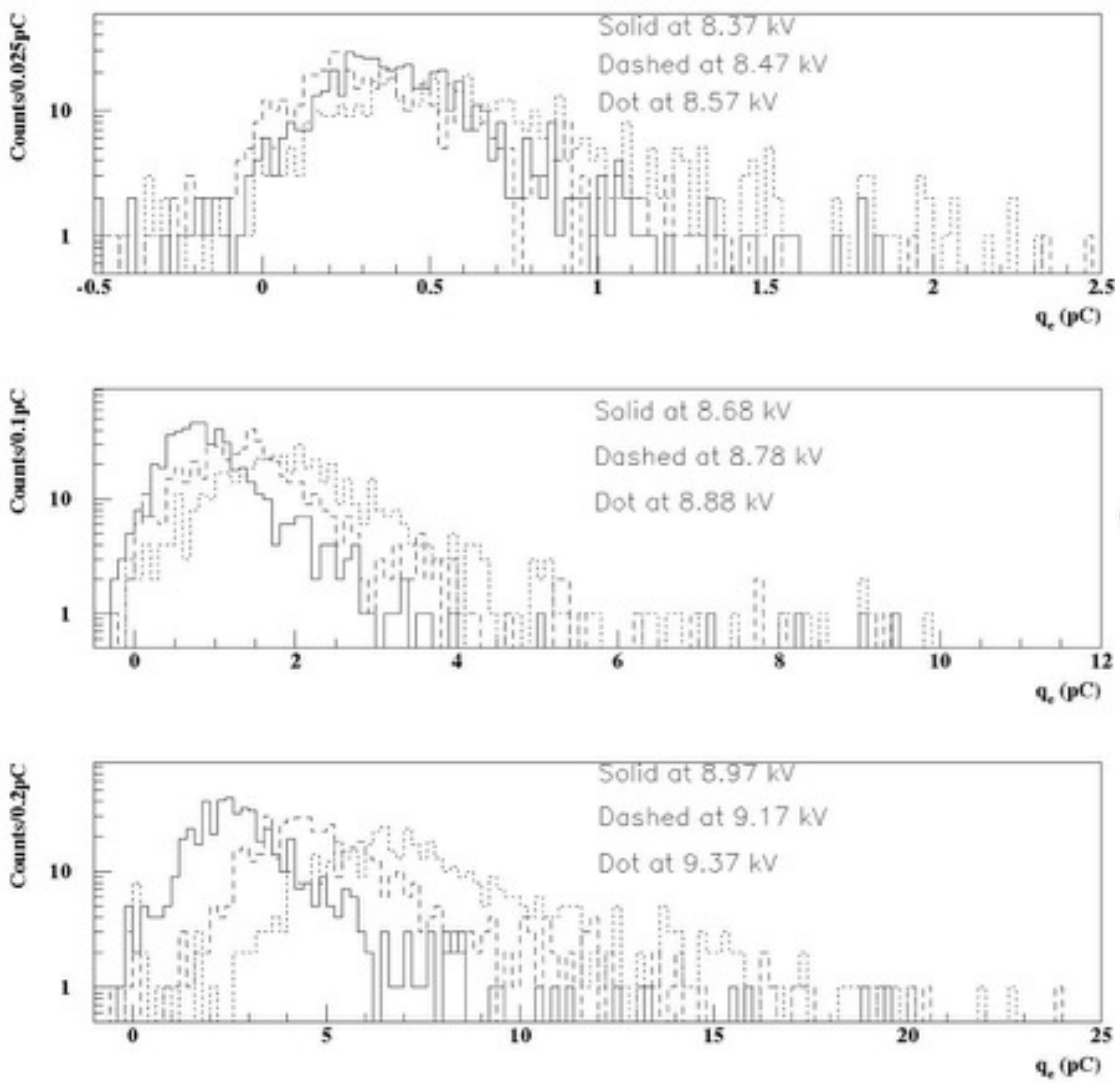


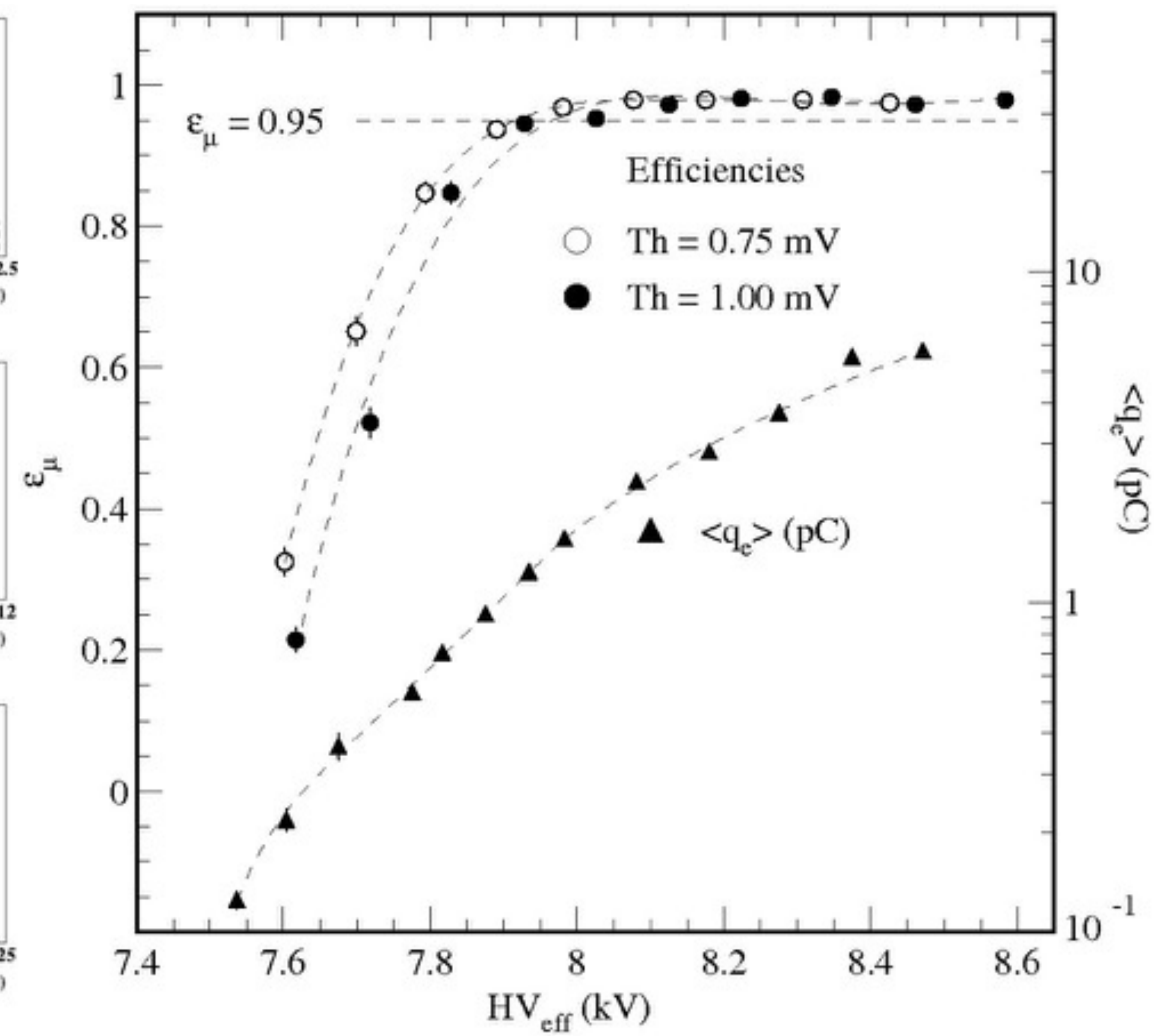
Charge distribution in 1.8mm



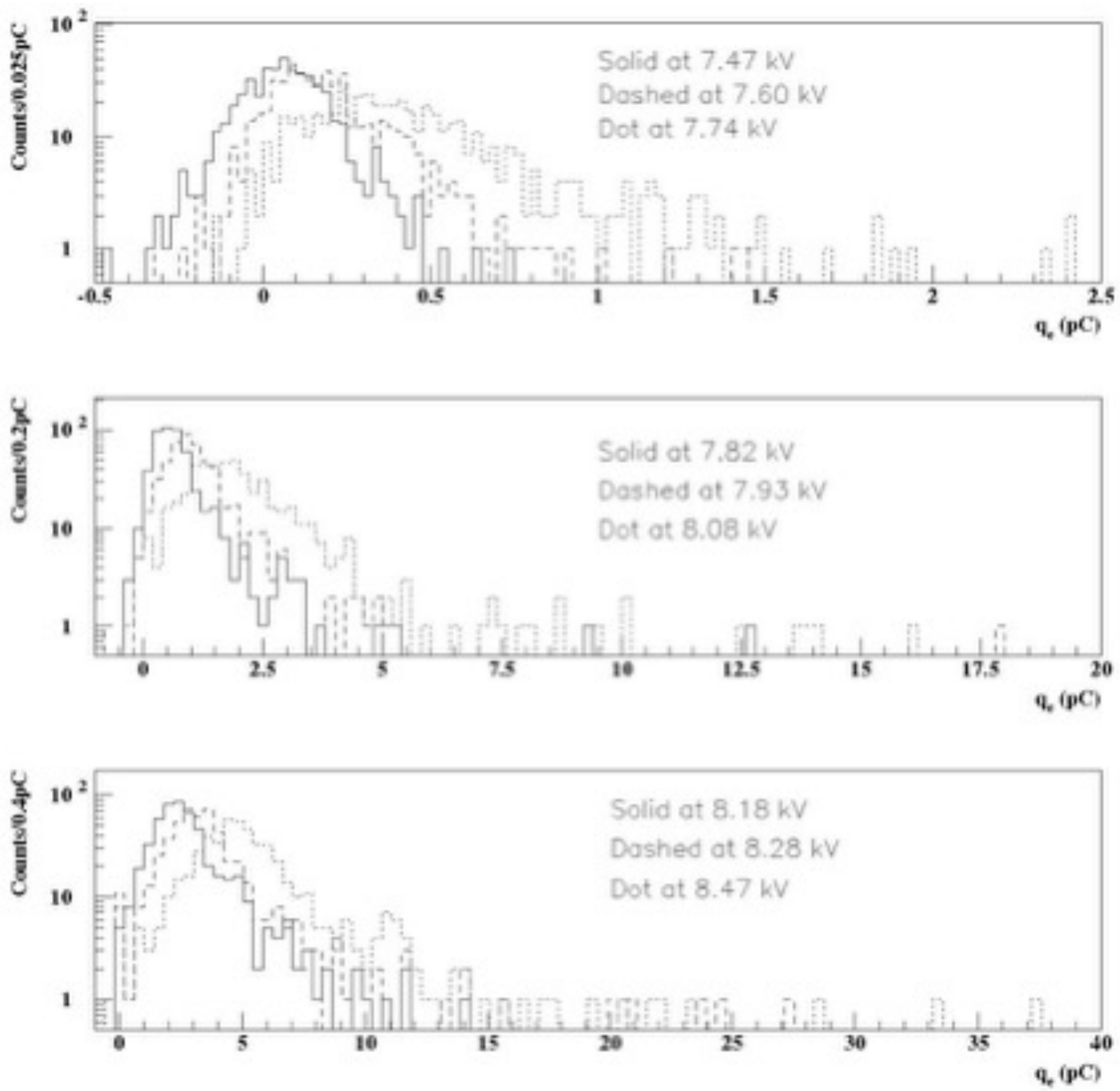


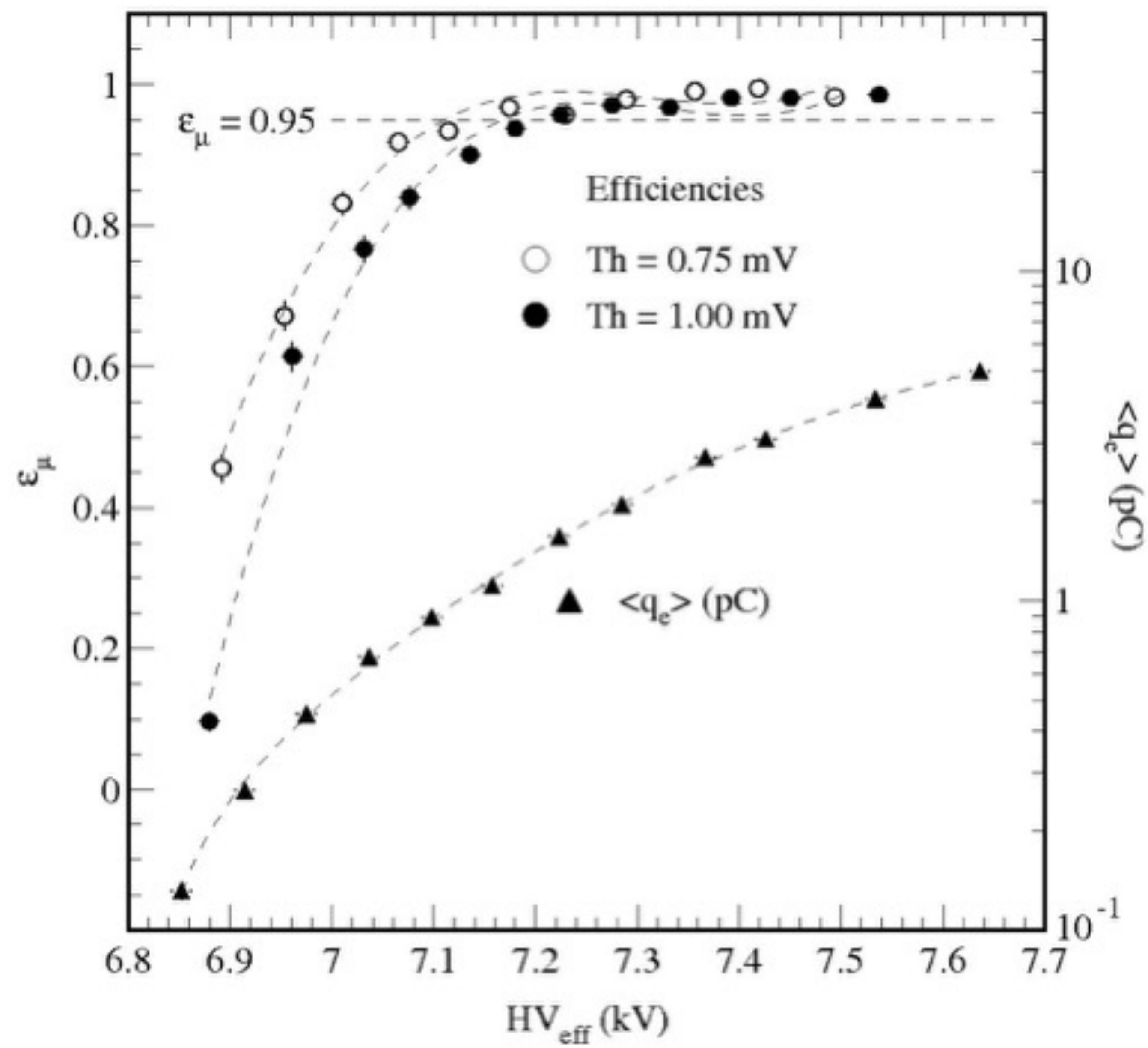
Charge distribution in 1.6mm





Charge distribution in 1.4mm





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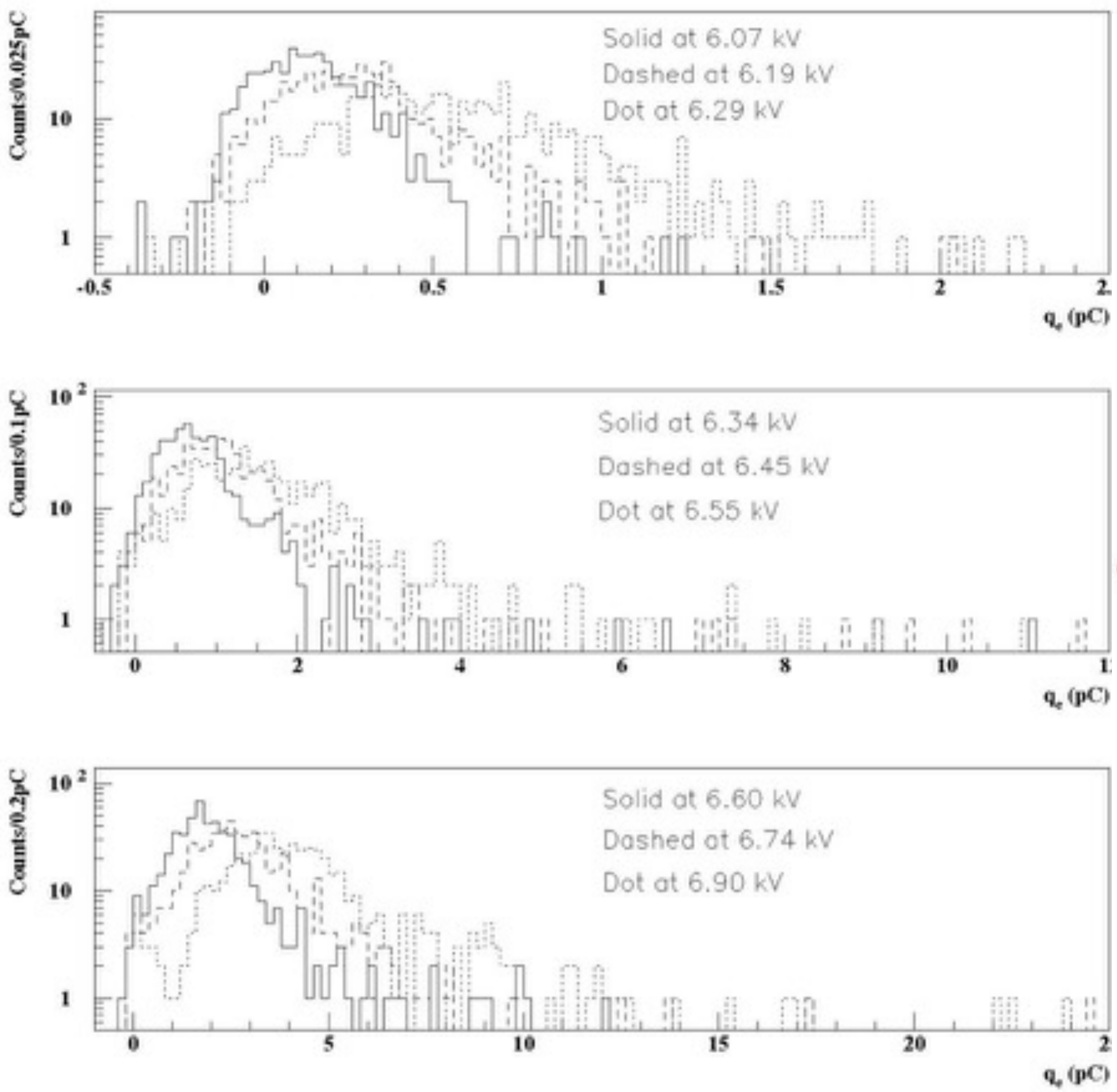
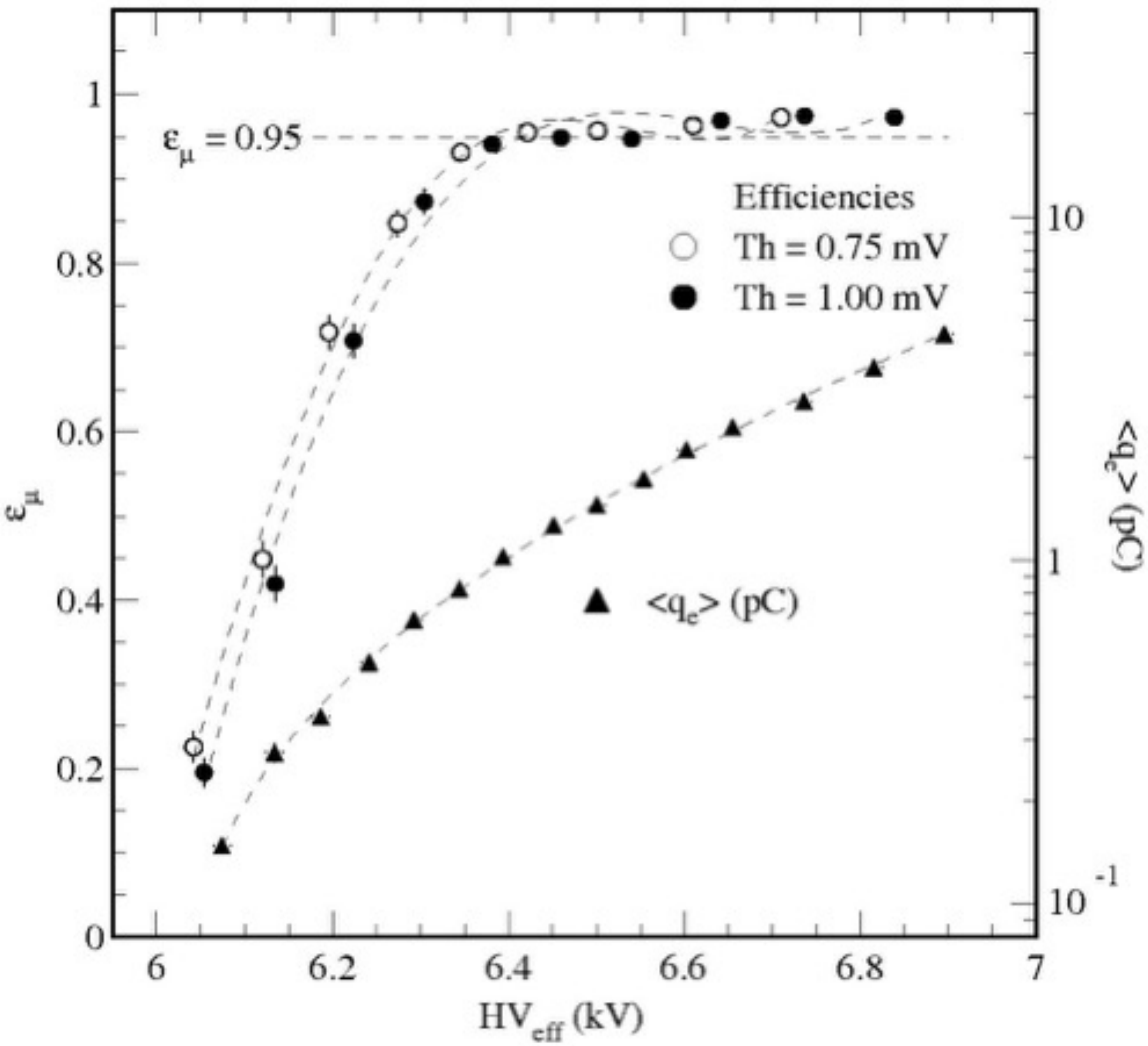
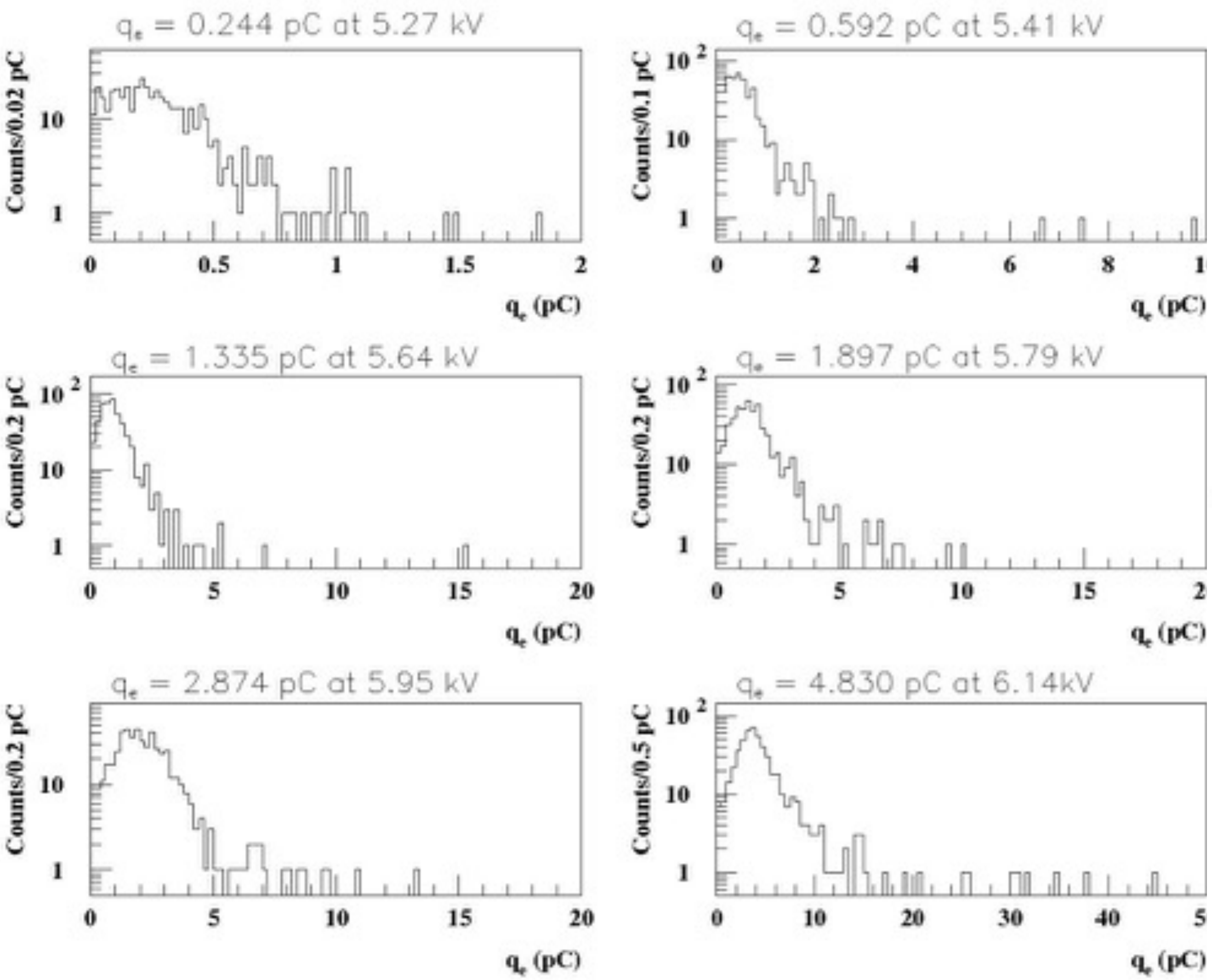
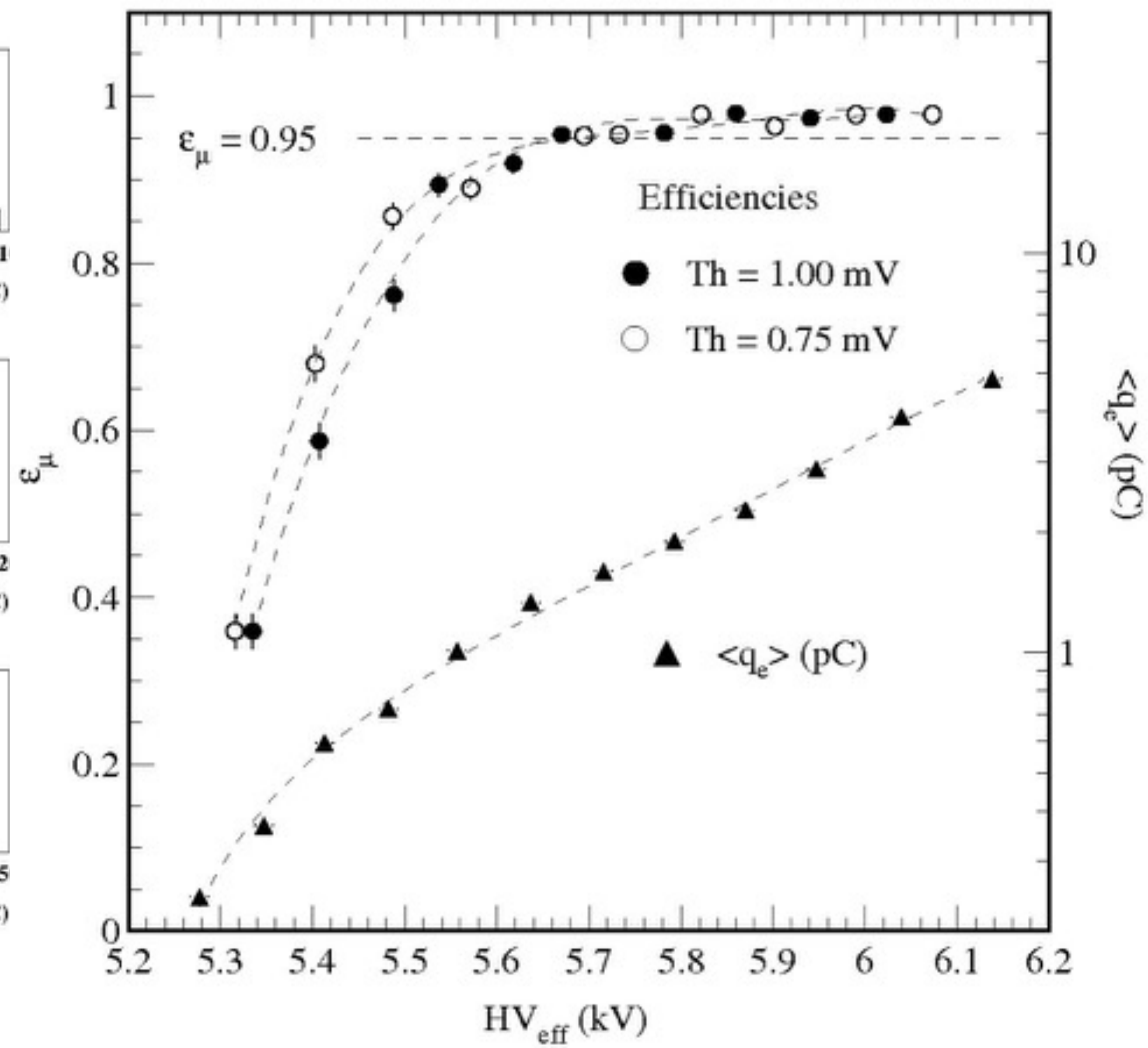
Charge distribution in 1.2mm





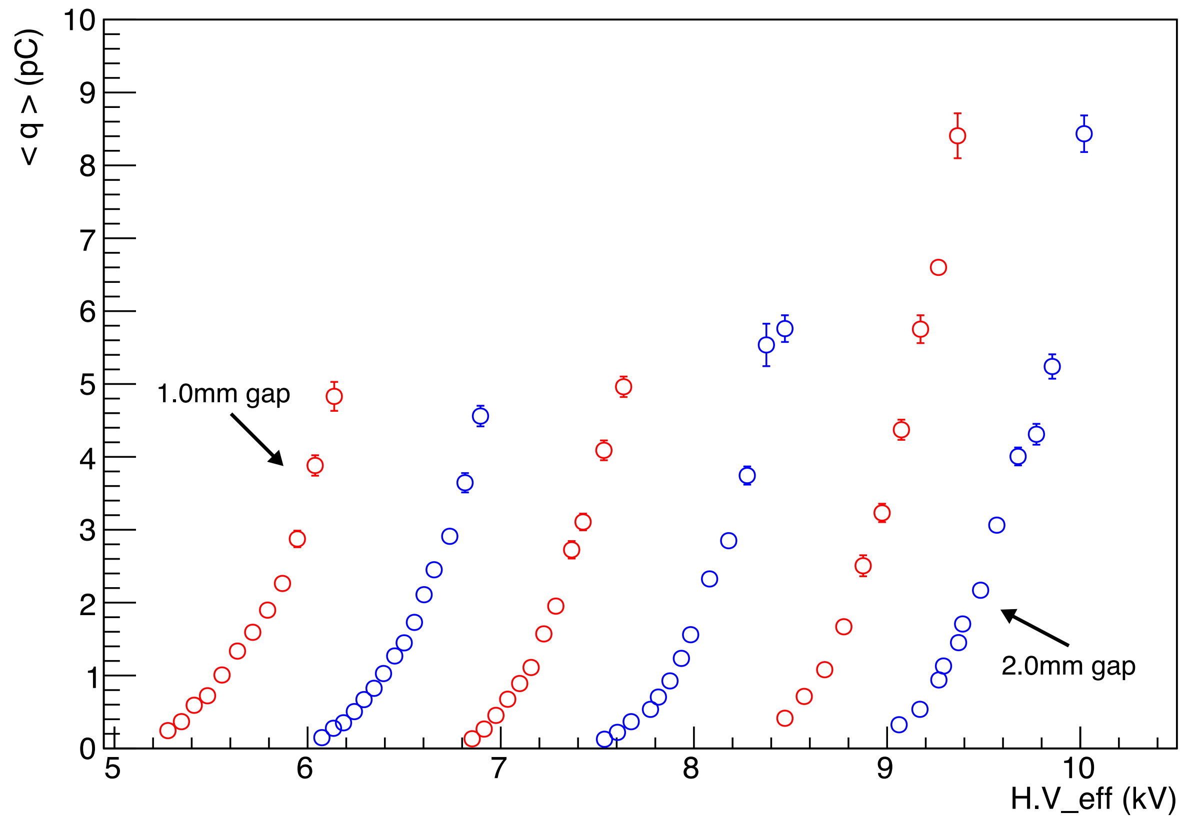
Charge distribution in 1.0mm

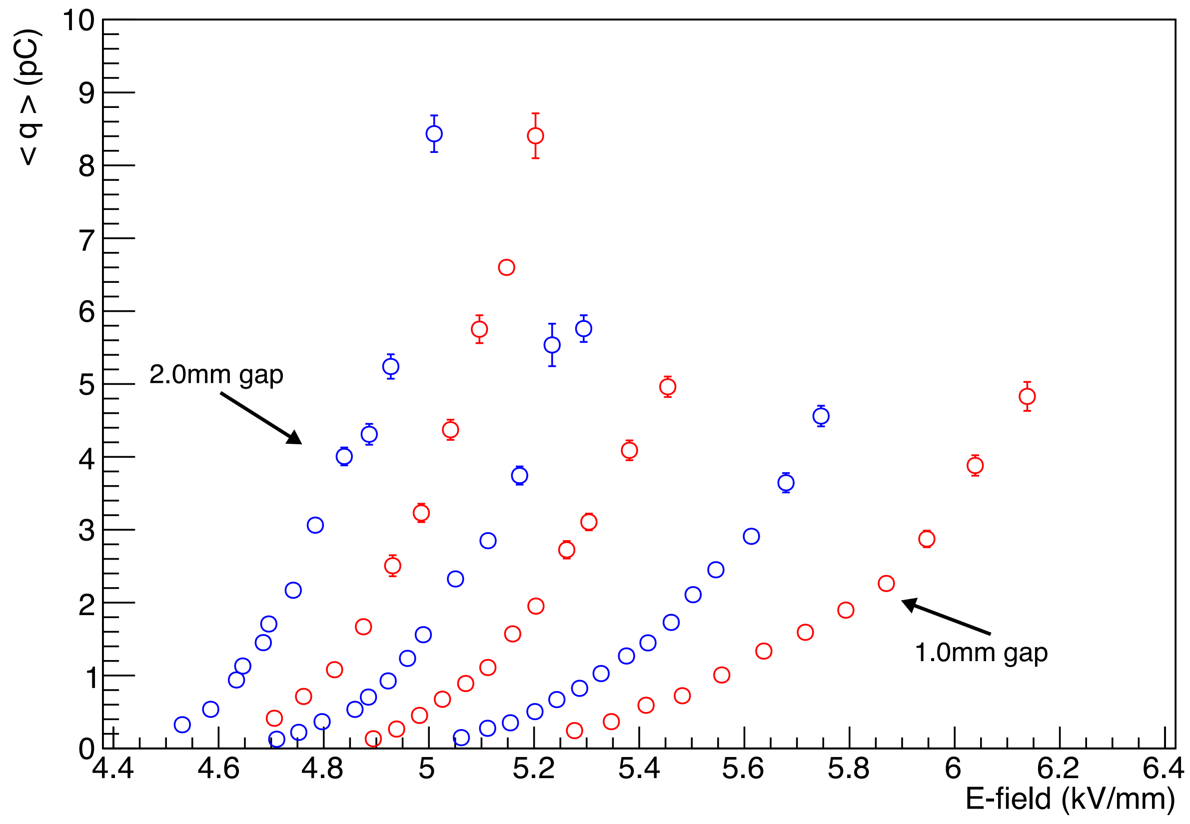




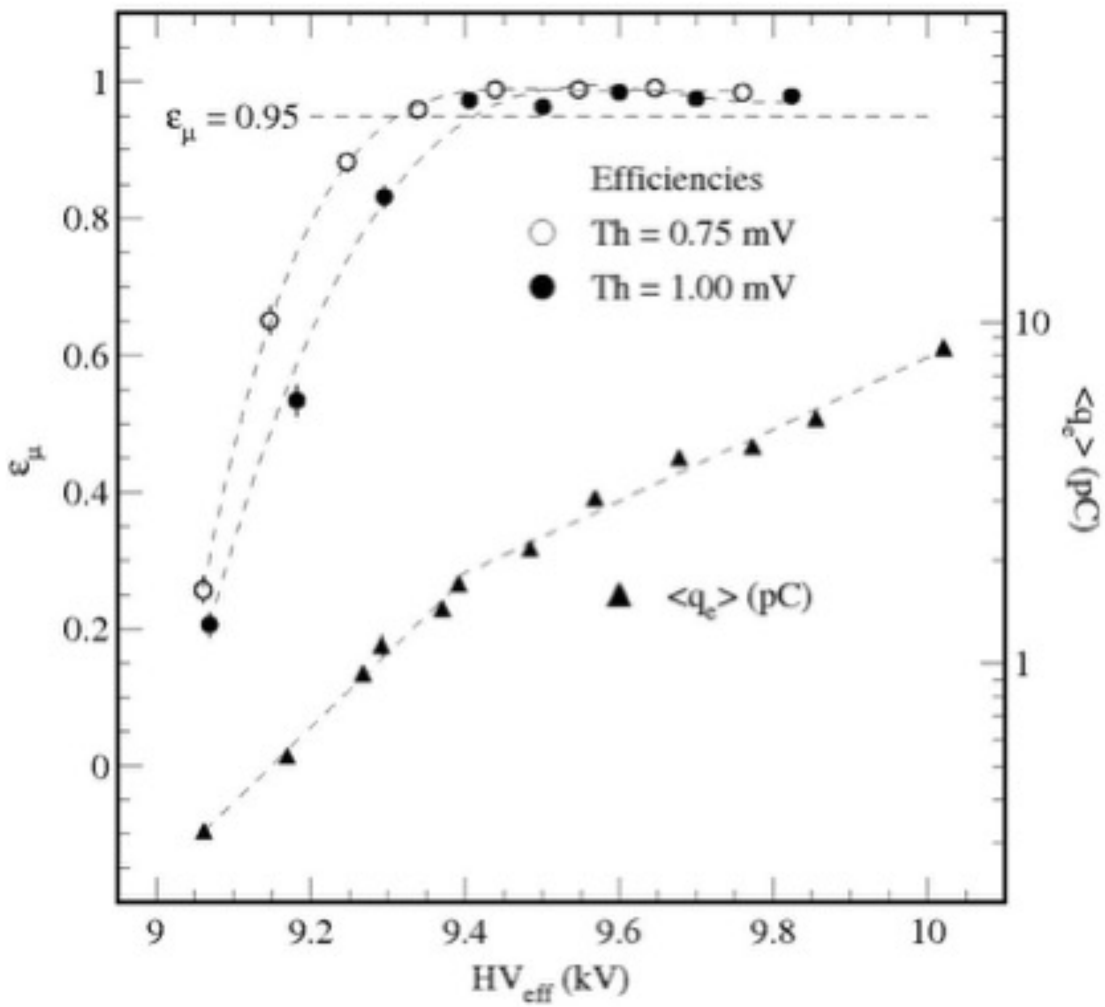
Charge Distributions in H.V & E-field

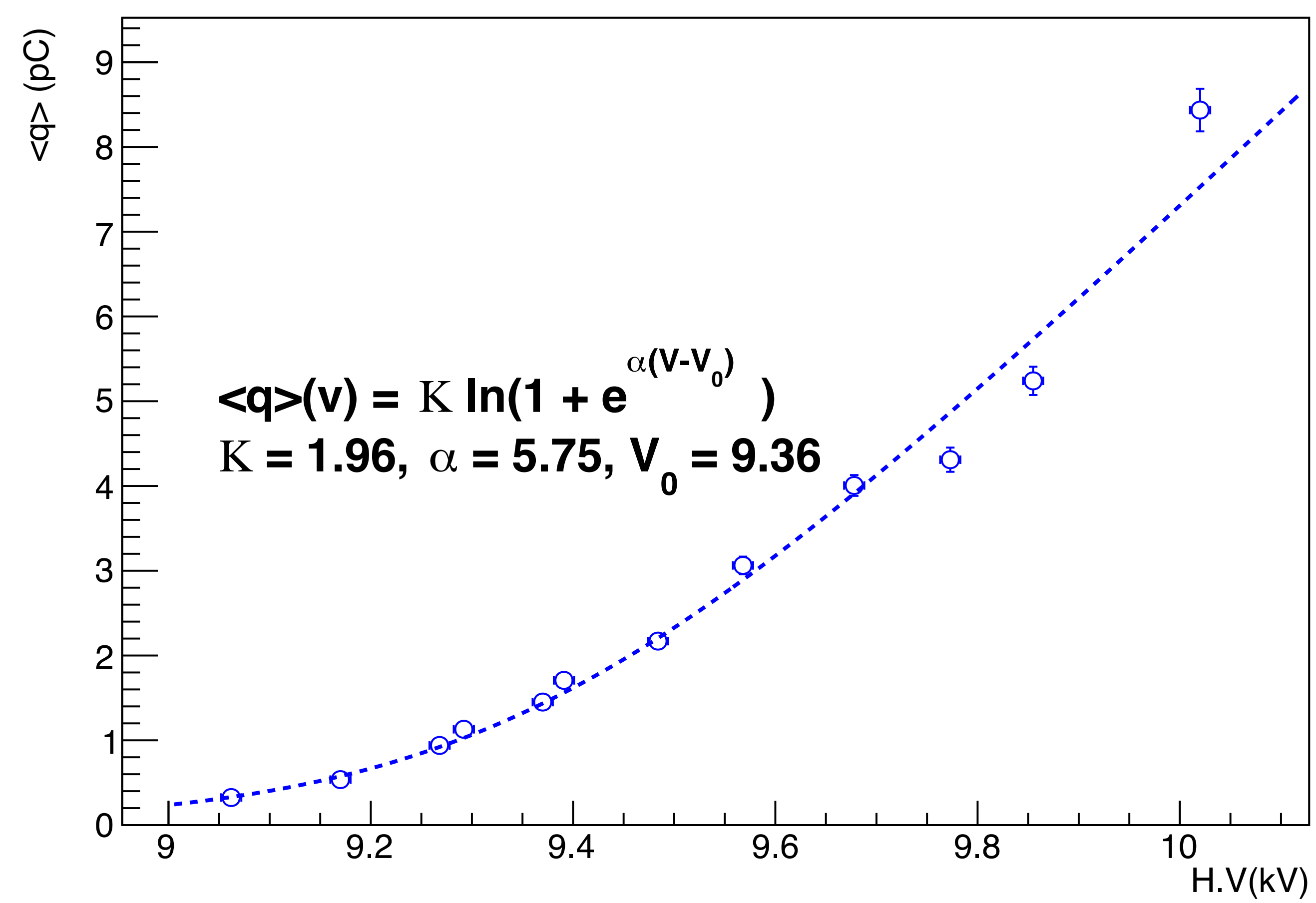
M. Abbrescia, et al., Nucl. Phys. B 78 (1999) 459
G. Aielli, et al., NIM A 508 (2003) 6



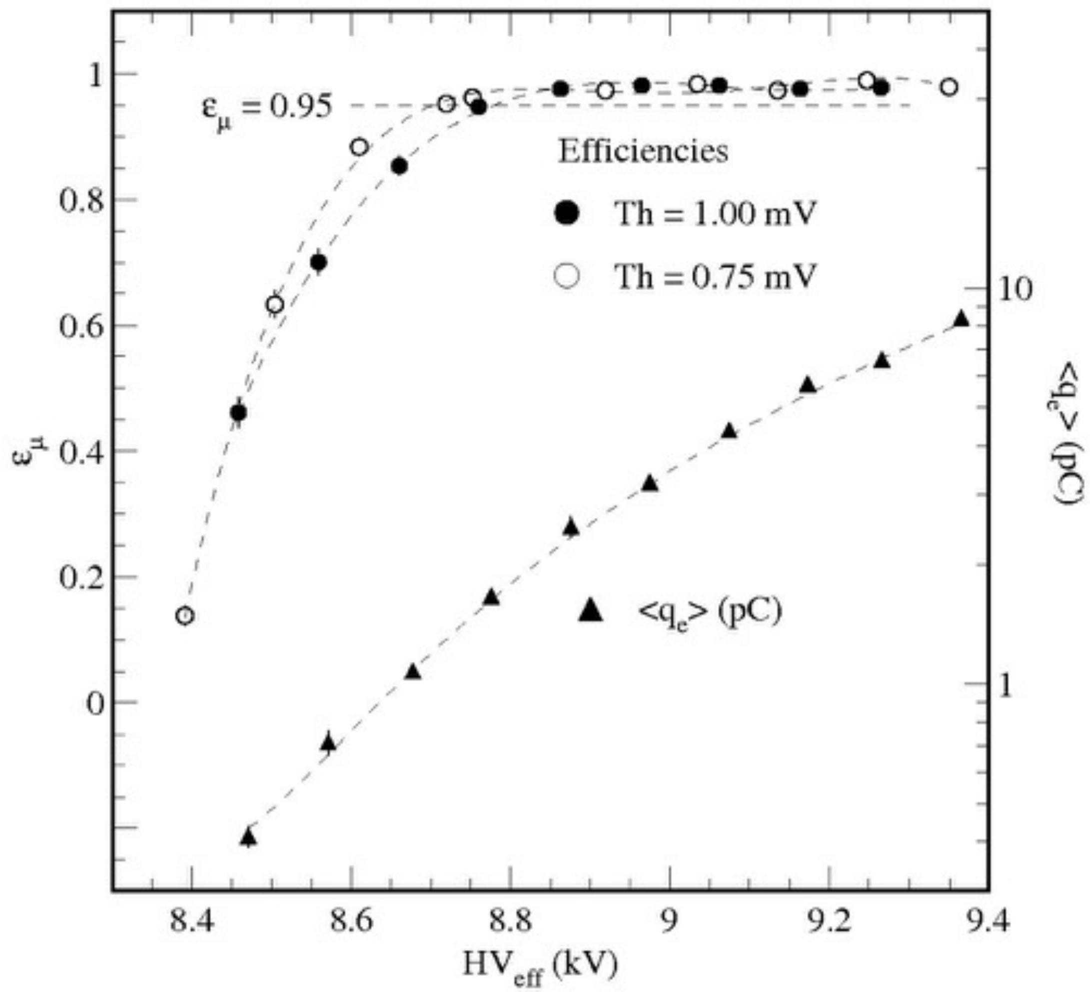


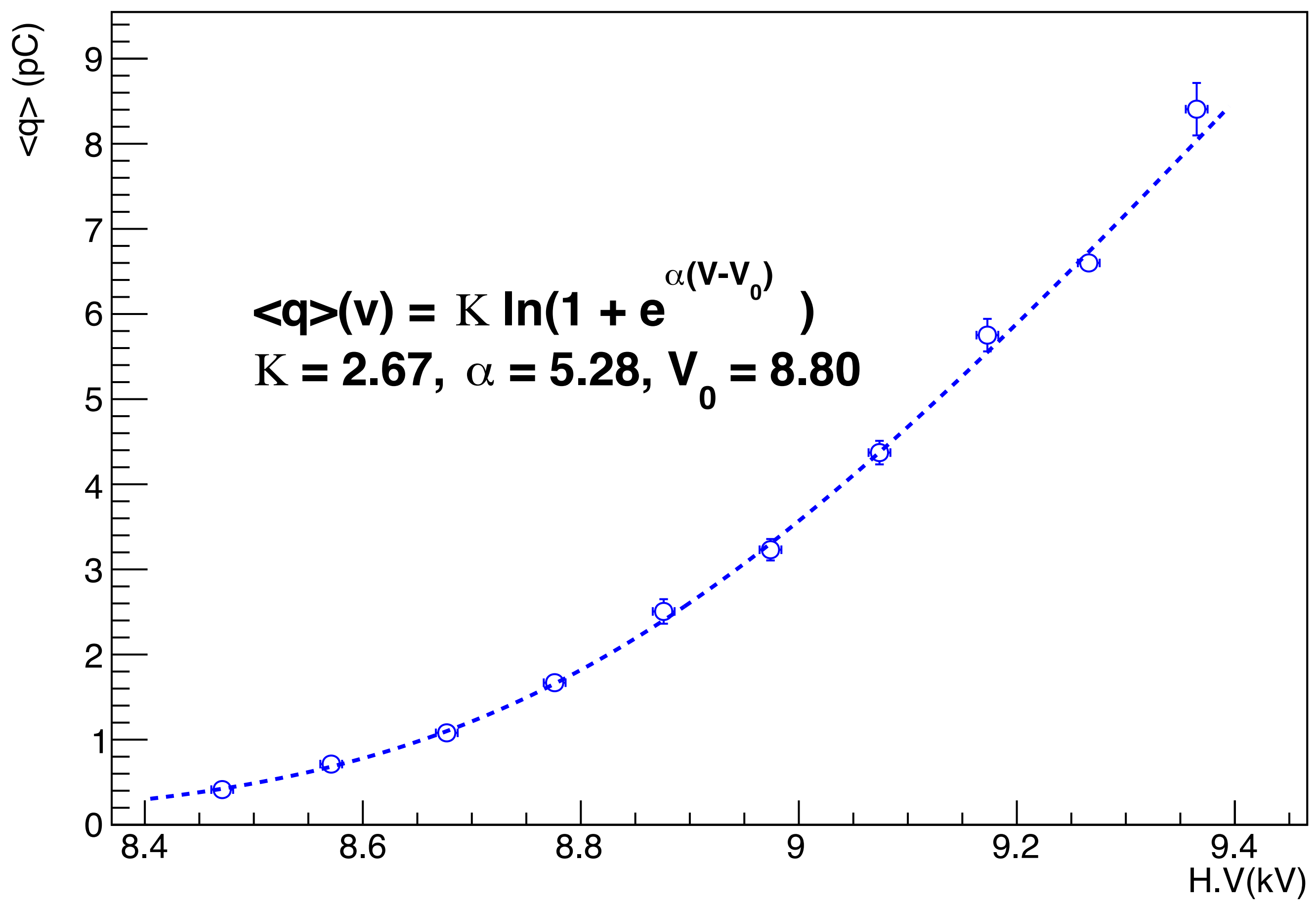
Charge distribution of 2.0mm gap fitting w the logistic function's cumulative



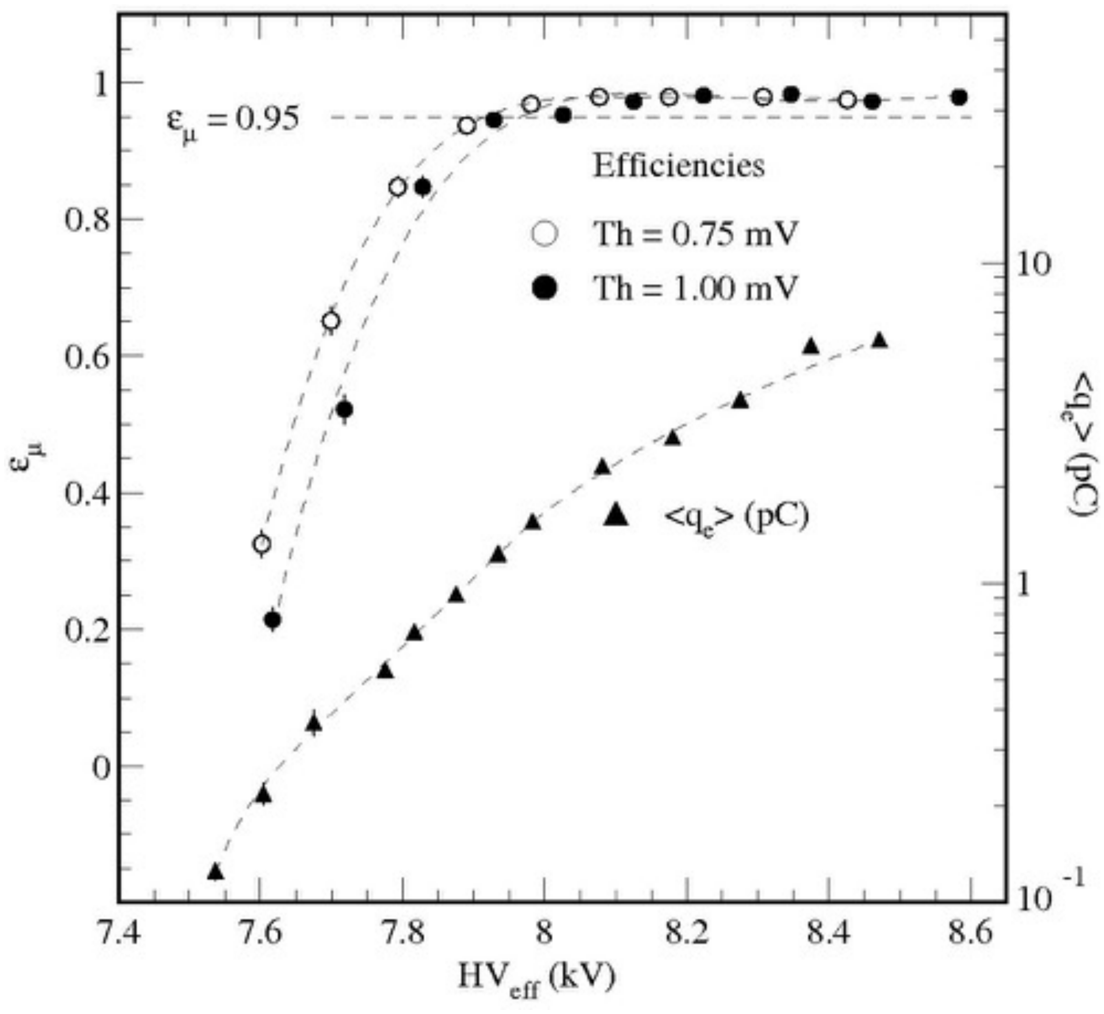


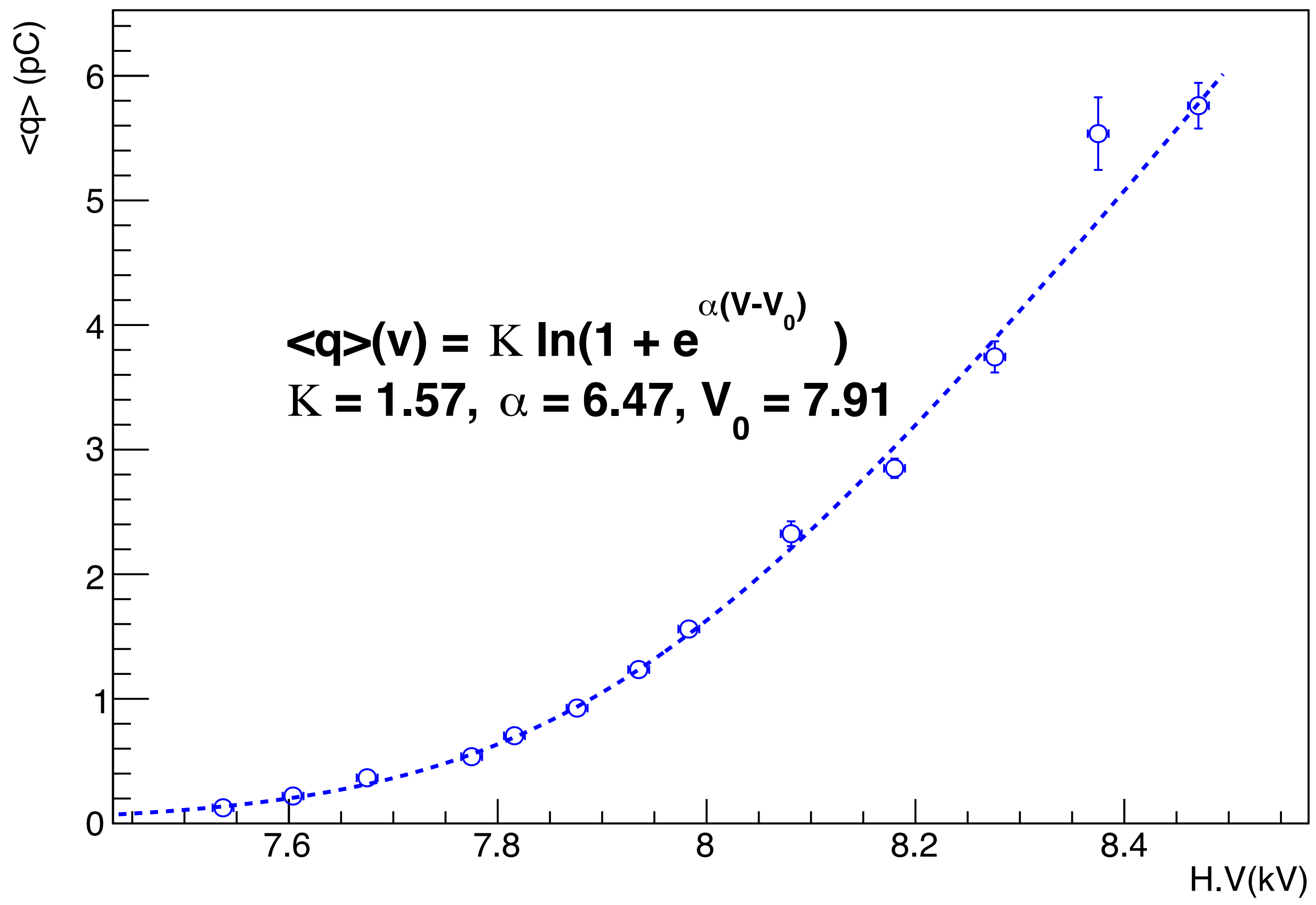
Charge distribution of 1.8mm gap fitting w the logistic function's cumulative





Charge distribution of 1.6mm gap fitting w the logistic function's cumulative





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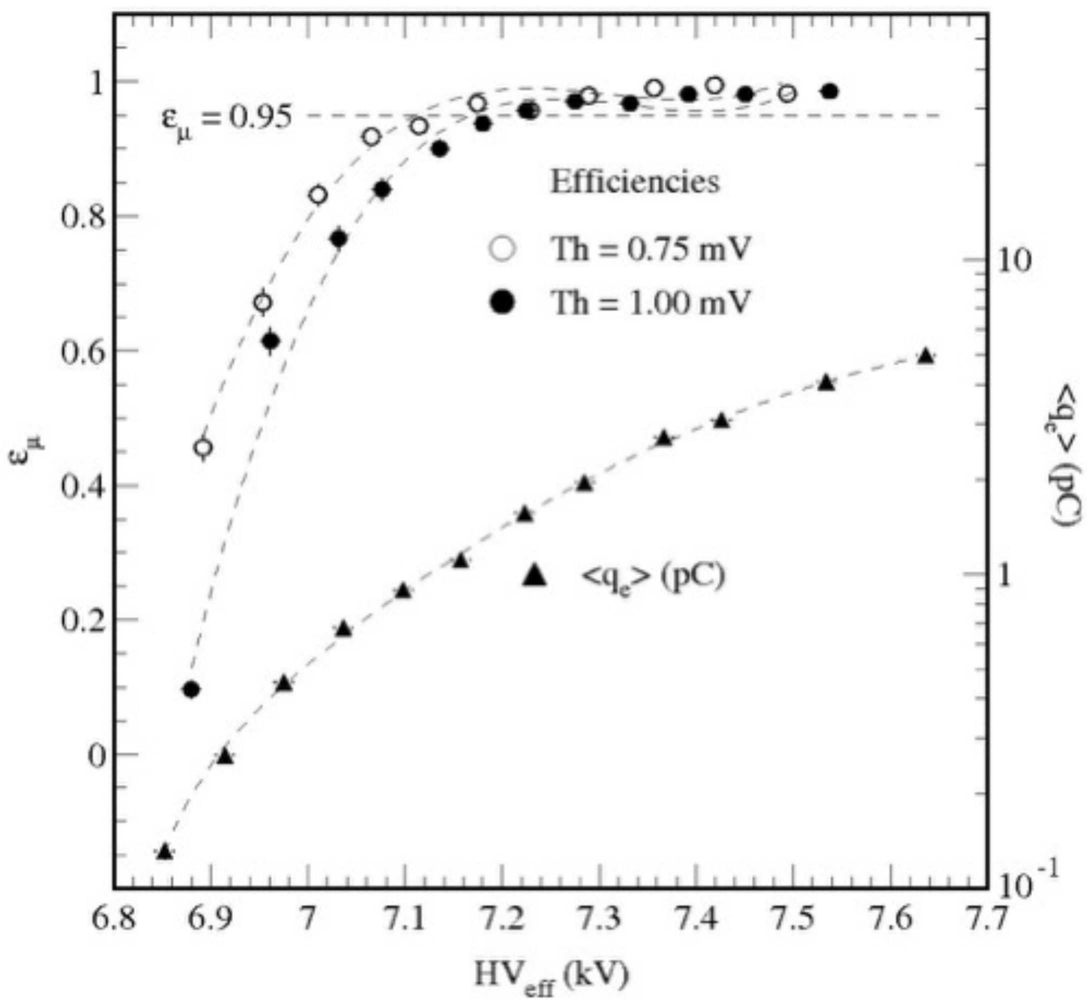
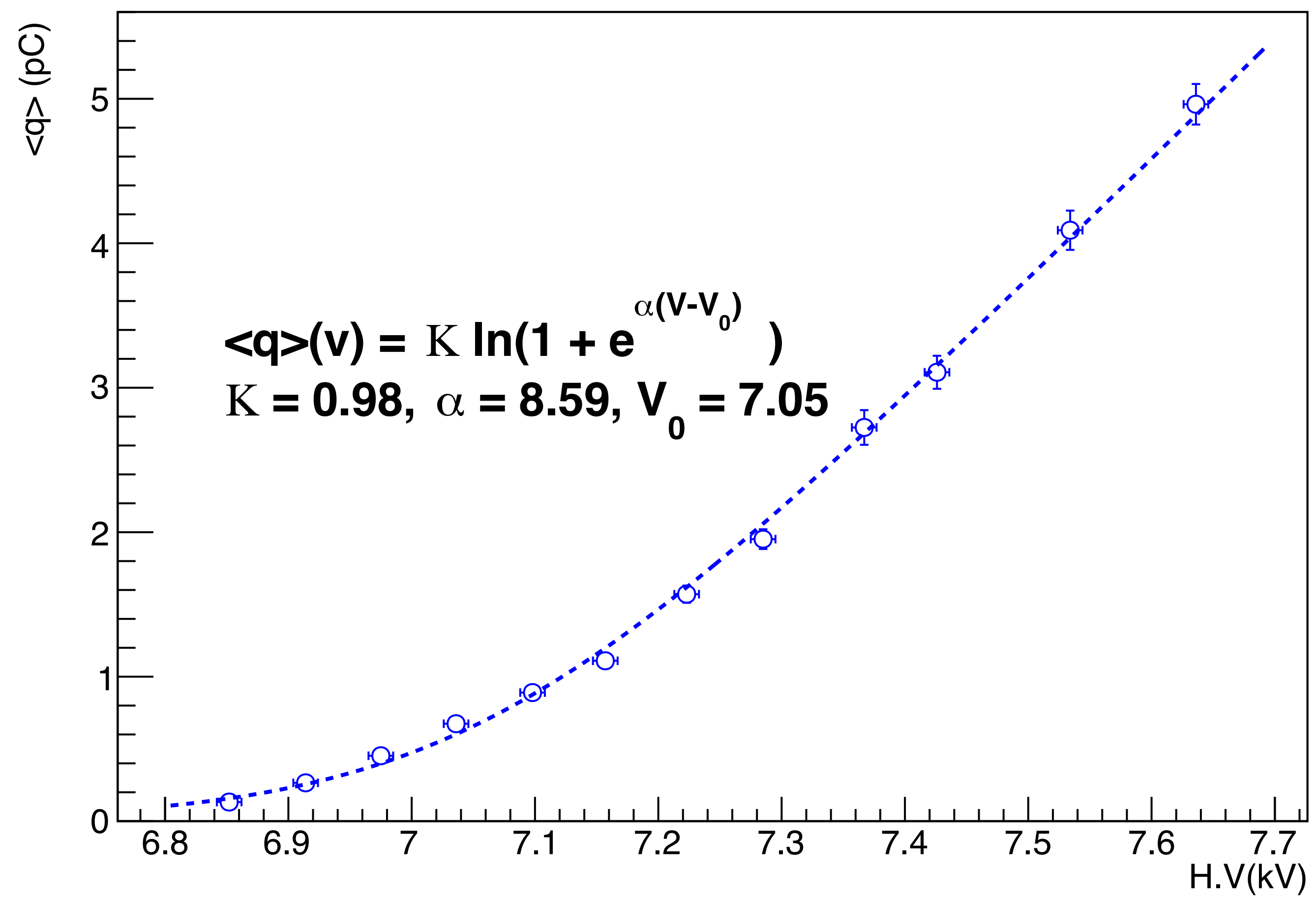
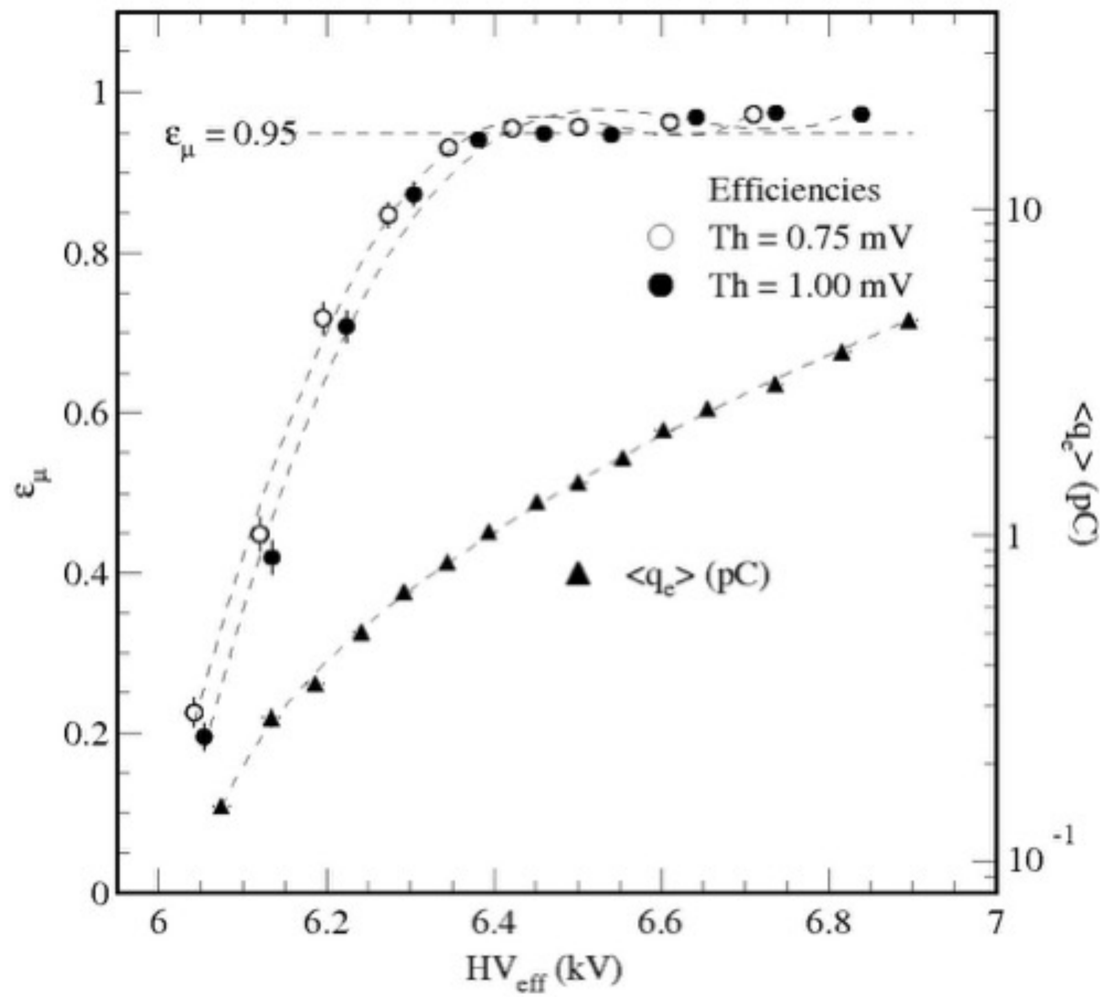
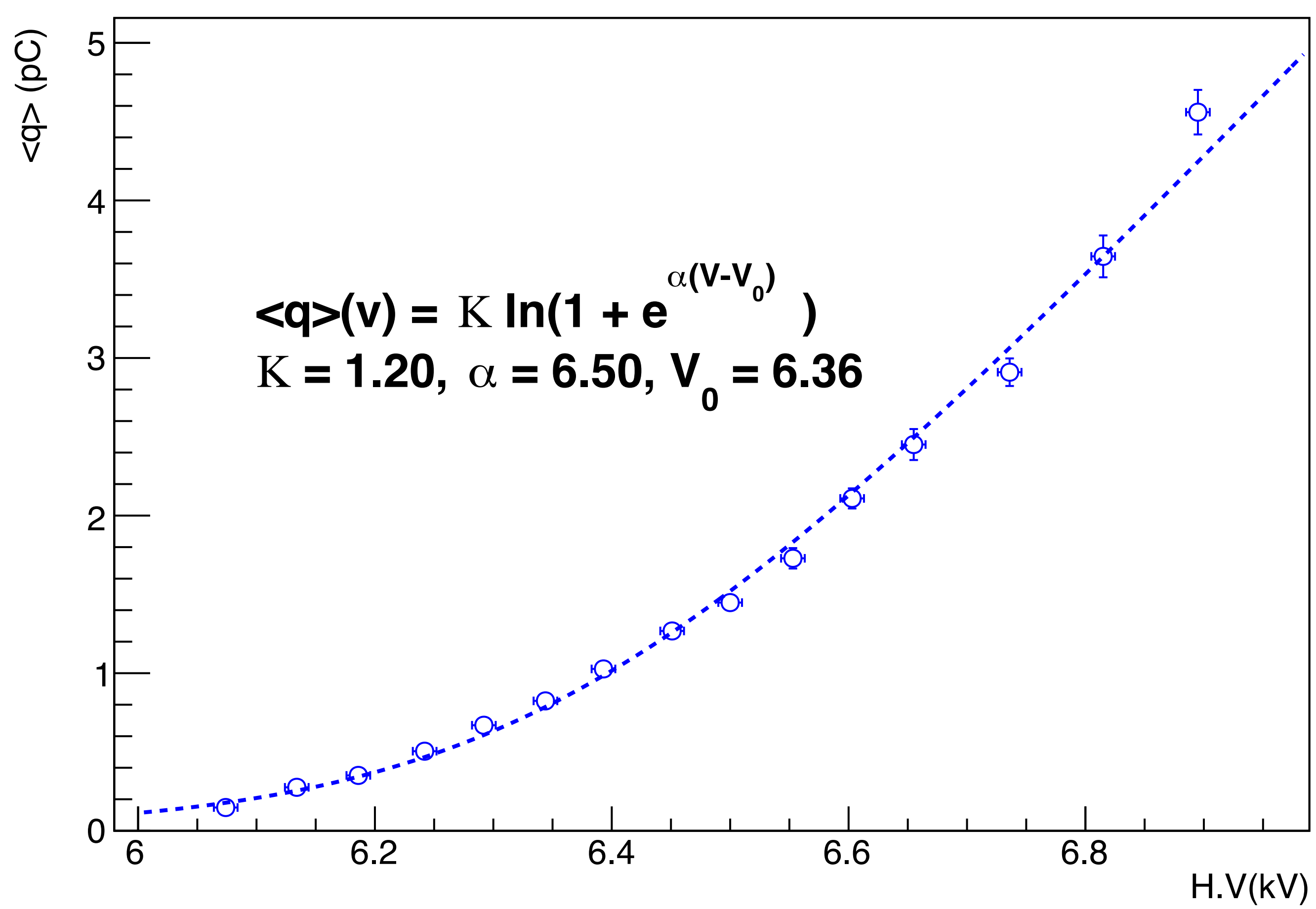
Charge distribution of 1.4mm gap fitting w the logistic function's cumulative



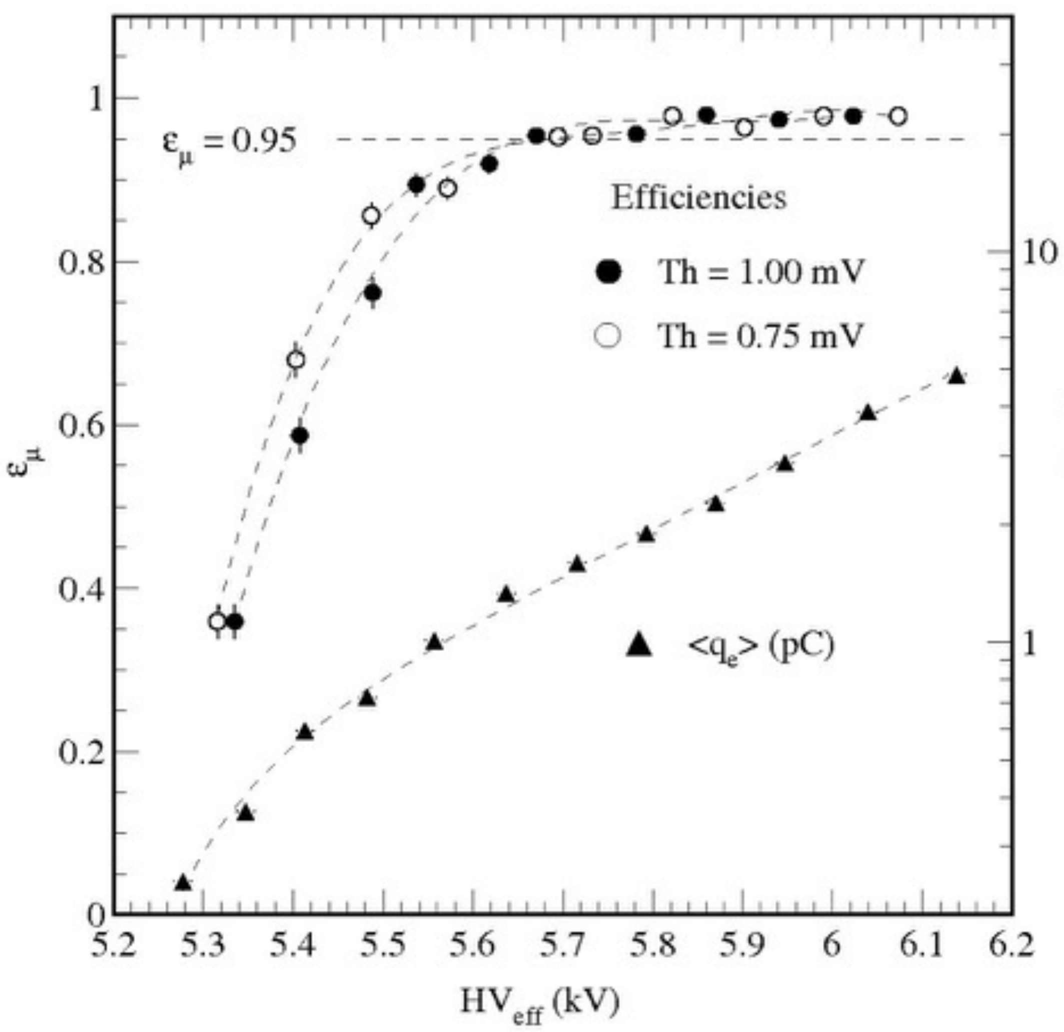


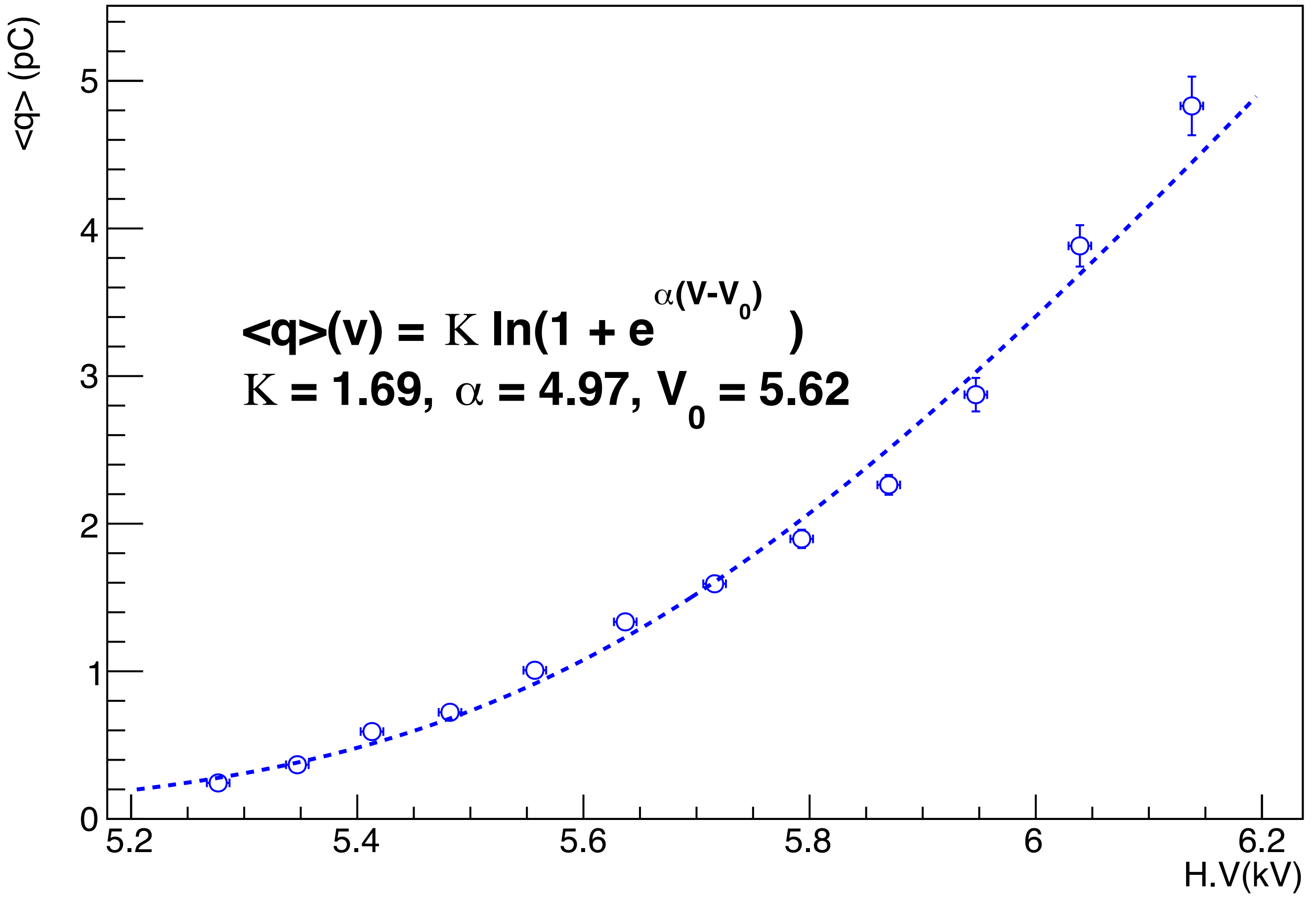
Charge distribution of 1.2mm gap fitting w the logistic function's cumulative





Charge distribution of 1.0mm gap fitting w the logistic function's cumulative





Summary of charge distributions

Gap (mm)	H.V_95%(kV) Th(1.0mV)	<q_e>(pC)	V_0(kV) in logistic fun.
2.0	9.39	1.658+/-0.108	9.36
1.8	8.77	1.621+/-0.072	8.80
1.6	7.99	1.607+/-0.080	7.91
1.4	7.21	1.473+/-0.069	7.05
1.2	6.50	1.448+/-0.049 (94%)	6.36
1.0	5.66	1.423+/-0.079	5.62

Conclusion

1. Charge distribution dependency on gap size behaves as expected
2. Charge growing exponentially fast at lower E-fields, slow at saturated higher E-fields.
3. Charge distribution indicates threshold setting
4. A smaller avalanche charge can be obtained by a lower threshold, allowing to lower H.V.
5. Fit of charge distribution <q_e> with logistic fun. performed
6. Further works in progress