

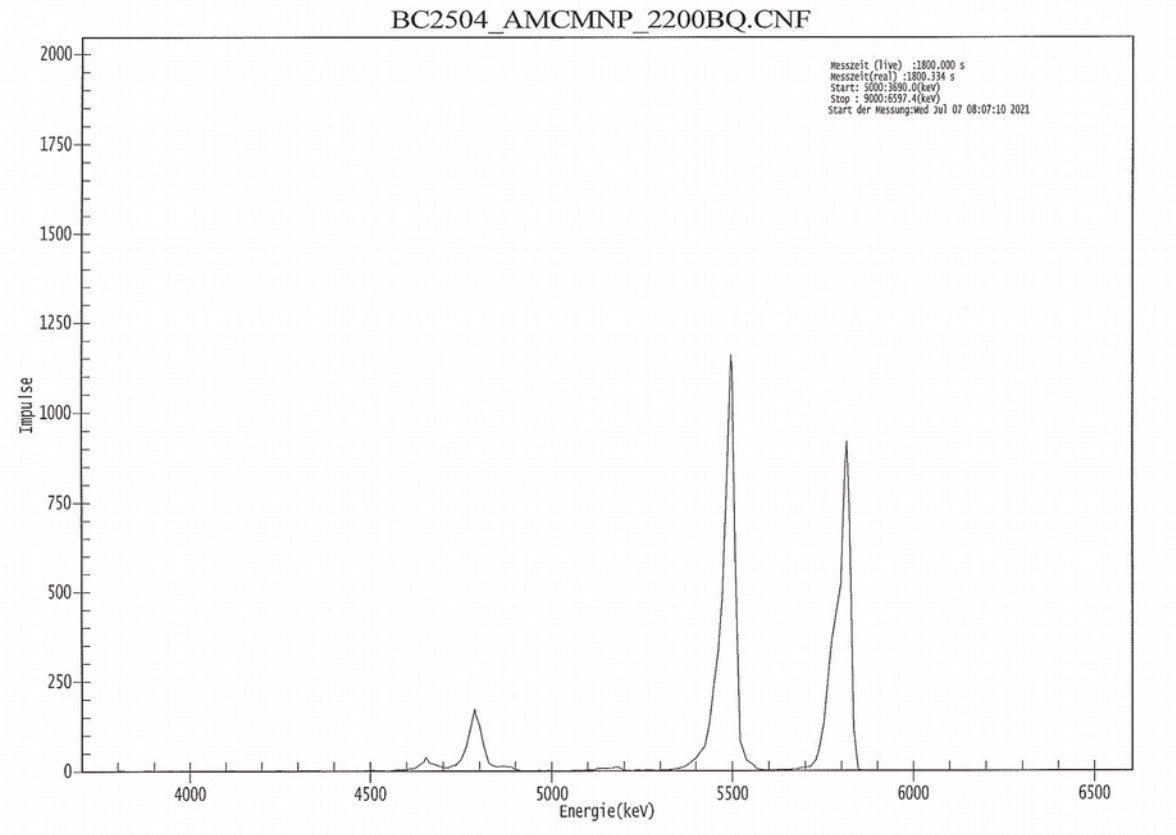
Measurements with alpha source

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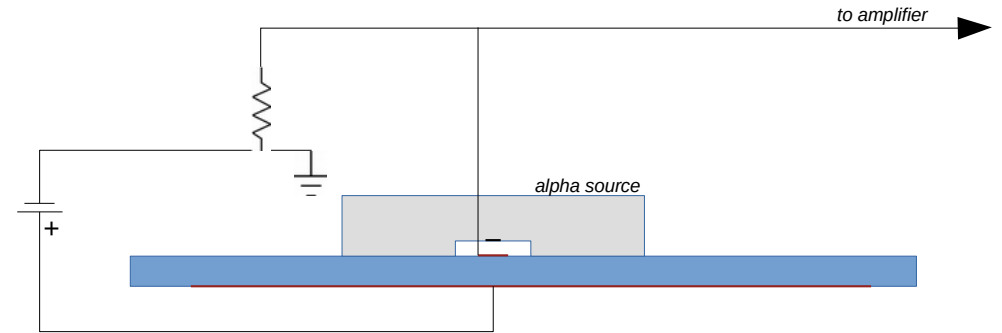
Alpha source

- ^{241}Am (1000 Bq)
 - 5.486 MeV (85%)
 - 5.443 MeV (13%)
 - 5.388 MeV (2%)
- ^{244}Cm (1000 Bq)
 - 5.765 MeV (23%)
 - 5.806 MeV (77%)
- ^{237}Np (200 Bq)
 - 4766 MeV (9%)
 - 4771 MeV (23%)
 - 4788 MeV (48%)
- Tolerance on activity: +/- 30%
- Active diameter: 7 mm



Setup

- Sapphire
 - 110 μm (Wuppertal)
 - 150 μm (US company)
- low noise HV power supply
- new home-made charge amplifier calibrated to 245 mV/fC
RMS noise ~ 12 mV ~ 0.05 fC 780 e $^-$



Working parameters

- HV up to 1200 V
- 6.5 mm nominal air gap from source to sapphire
7 mm used for calculations to keep into account also the ~ 100 nm of Ti-Ag deposition
- Estimated Alfa kinetic energy and ionization charge produced

<i>Average initial kinetic energy</i>		<i>Range in sapphire</i>	<i>Charge created</i>
<i>initial</i>	<i>at surface</i>	<i>direction normal to surface</i>	
MeV	MeV	um	fC
5.638	4.985	10.900	29.540

Simple model

- In a setup with uniform electric field inside the sapphire, with:

τ electrons lifetime
 μ electron mobility
 d sapphire thickness
 V electric field potential
 v_d drift velocity
 p average electron drift path
 k fraction of path to thickness

- we have:

$$v_d = \mu E$$

$$p = v_d \tau$$

$$k = p/d = \frac{\mu E \tau}{d} = \frac{\mu \tau V}{d^2}$$

CCE is related to k by Hecht equation:

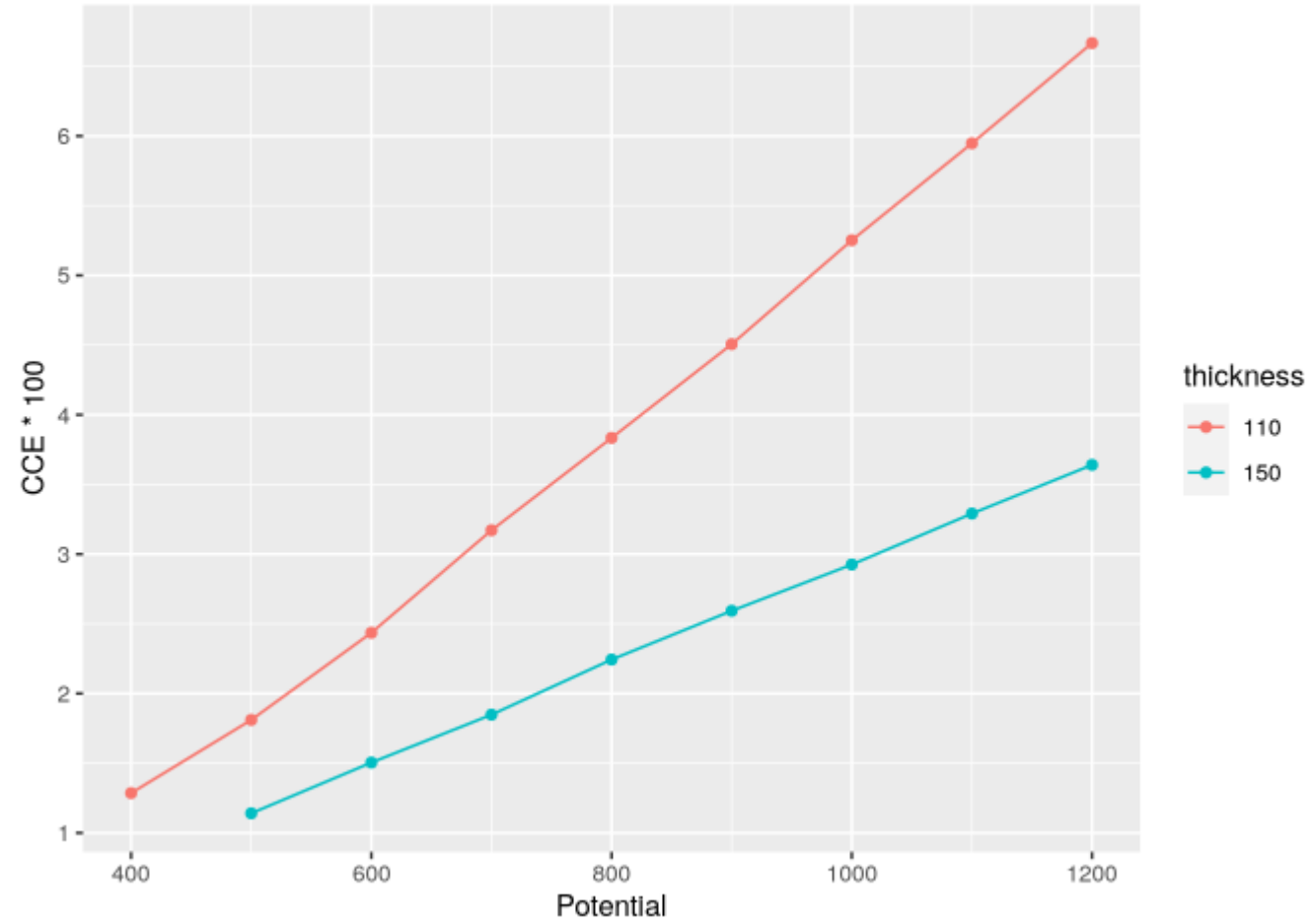
$$CCE = k(1 - \exp(-1/k))$$

and we can fit the data as a function of V for determining $\mu \tau$

Results

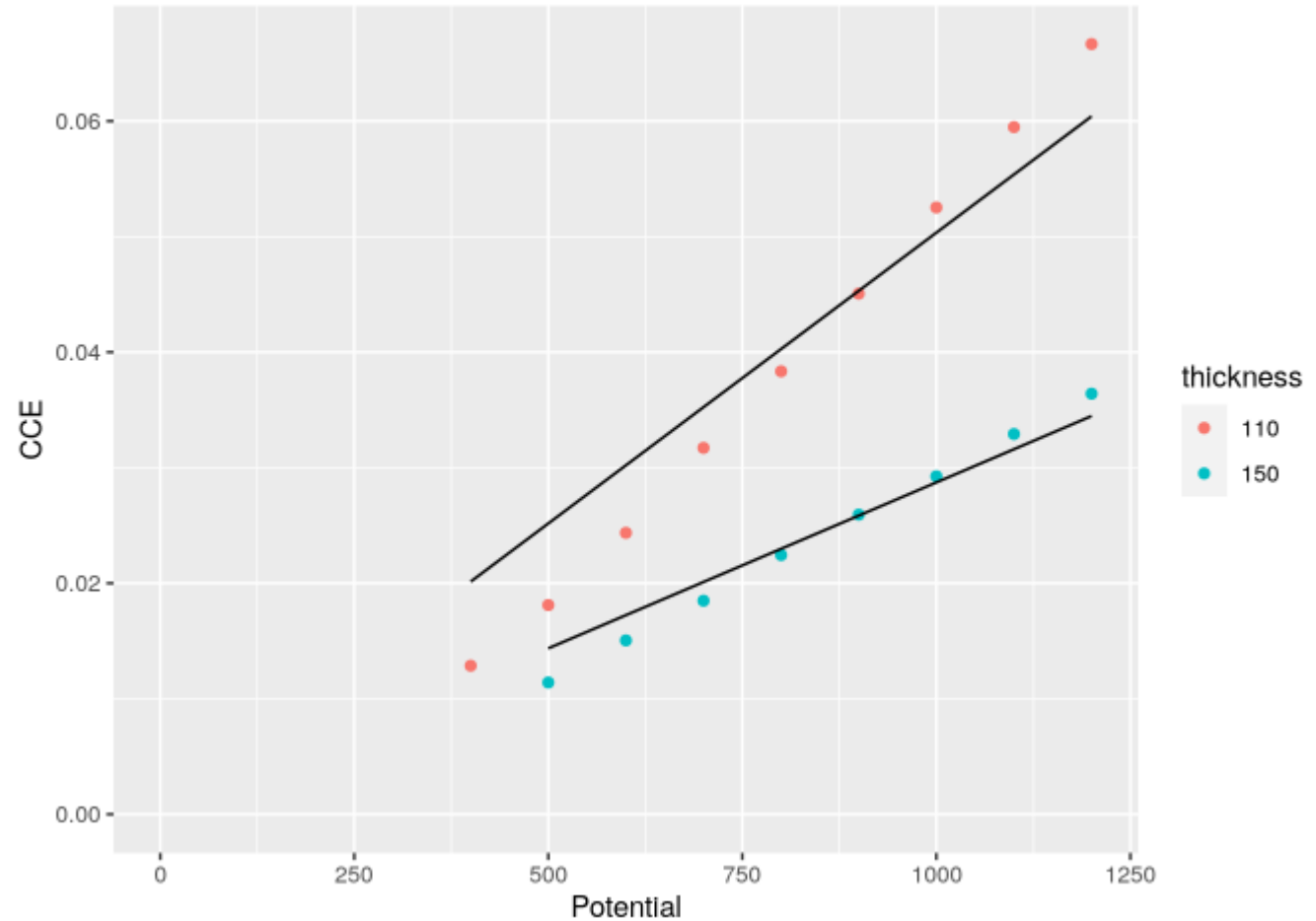
thickness um	Potential V	Signal_low mV	Signal_high mV	Signal fC	CCE
110	400	-94.3	-93.5	0.38	1.29%
110	500	-133.5	-131.0	0.54	1.81%
110	600	-179.5	-176.3	0.73	2.44%
110	700	-233.3	-229.9	0.95	3.17%
110	800	-282.3	-277.7	1.14	3.83%
110	900	-332.4	-325.8	1.34	4.51%
110	1000	-388.5	-378.6	1.57	5.25%
110	1100	-440.0	-428.7	1.77	5.95%
110	1200	-489.8	-483.9	1.99	6.67%
150	500	-83.8	-82.8	0.34	1.14%
150	600	-110.8	-109.0	0.45	1.50%
150	700	-136.1	-133.9	0.55	1.85%
150	800	-165.2	-162.5	0.67	2.24%
150	900	-190.8	-188.0	0.77	2.59%
150	1000	-215.6	-211.7	0.87	2.93%
150	1100	-243.4	-237.3	0.98	3.29%
150	1200	-268.5	-263.2	1.09	3.64%

Results: CCE



Results: $\mu \times \tau$

- Points do not align on straight line from the origin as foreseen by the Hecht equation
- $\mu \tau = 6.09 \times 10^{-9} \text{ cm}^2/\text{V}$ for 110 μm sapphire
 $\mu \tau = 6.46 \times 10^{-9} \text{ cm}^2/\text{V}$ for 150 μm sapphire



Results: $\mu \times \tau$

- Fitting for:

$$CCE = CCE_0 + k(1 - \exp(-1/k))$$

- one obtains:

$$\mu \tau = 8.25 \times 10^{-9} \text{ cm}^2/\text{V}$$

$$CCE_0 = -0.0157$$

for 110 μm sapphire

$$\mu \tau = 8.04 \times 10^{-9} \text{ cm}^2/\text{V}$$

$$CCE_0 = -0.0064$$

for 150 μm sapphire

- with $\mu \sim 600 \text{ cm}^2/\text{Vs}$
 $\tau \sim 13 \text{ ps}$

