Measurements with alpha source

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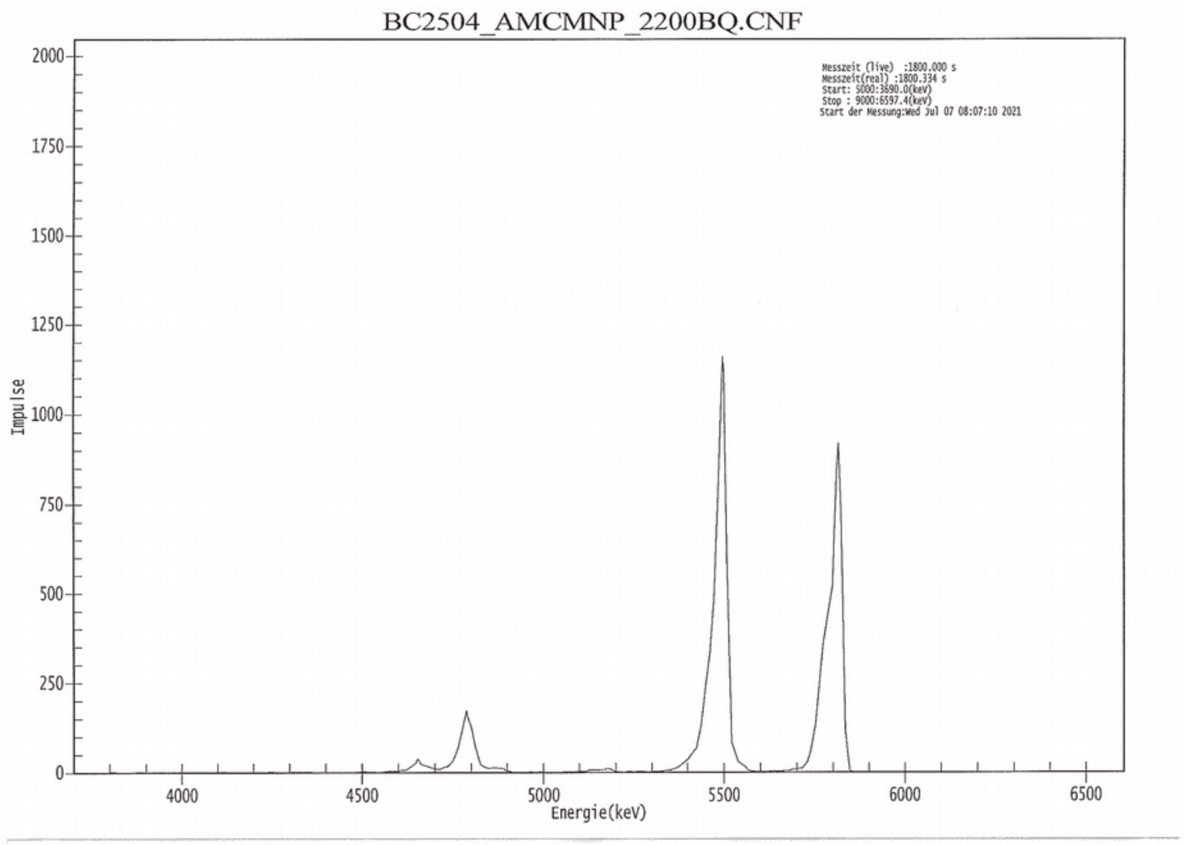
2 March 2022

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



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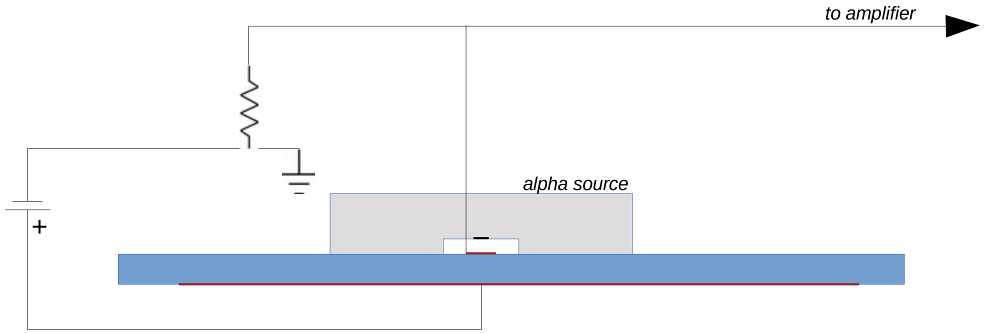
Setup



- Sapphire
  - 110 um (Wuppertal)
  - 150 um (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 accout also the ~ 100 nm of Ti-Ag deposition
- Estimated Alfa kinetic energy and ionization charge produced

Average inital kinetic energy		*Range in sapphire*	*Charge created*
initial	*at surface*	*direction normal to surface*	
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:

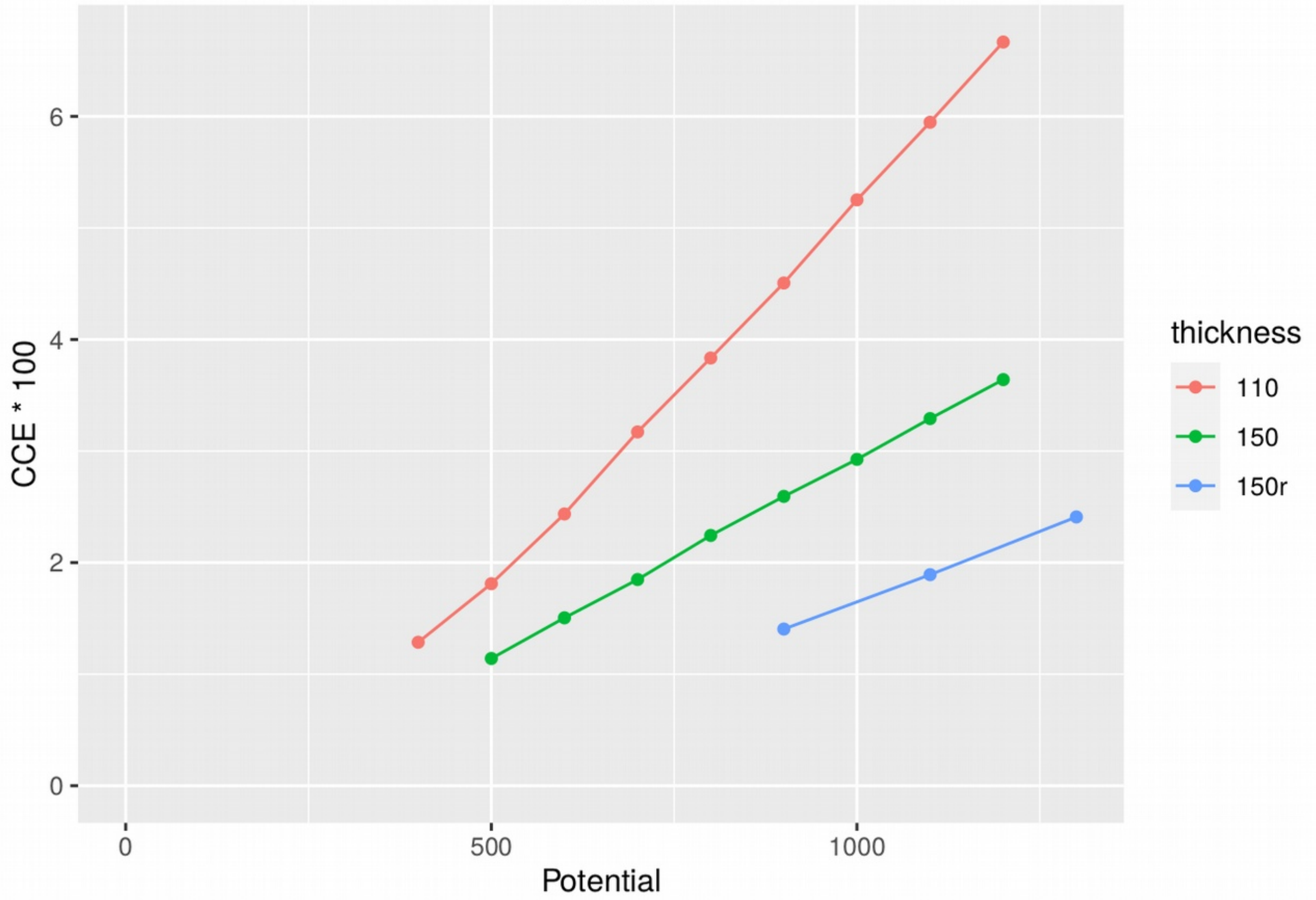
$$CCE = k(1 - \exp(-1/k))$$

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%
150.0	900.0	101.3	103.8	0.42	1.40%
150.0	1,100.0	137.2	139.1	0.56	1.89%
150.0	1,300.0	175.0	176.9	0.72	2.41%

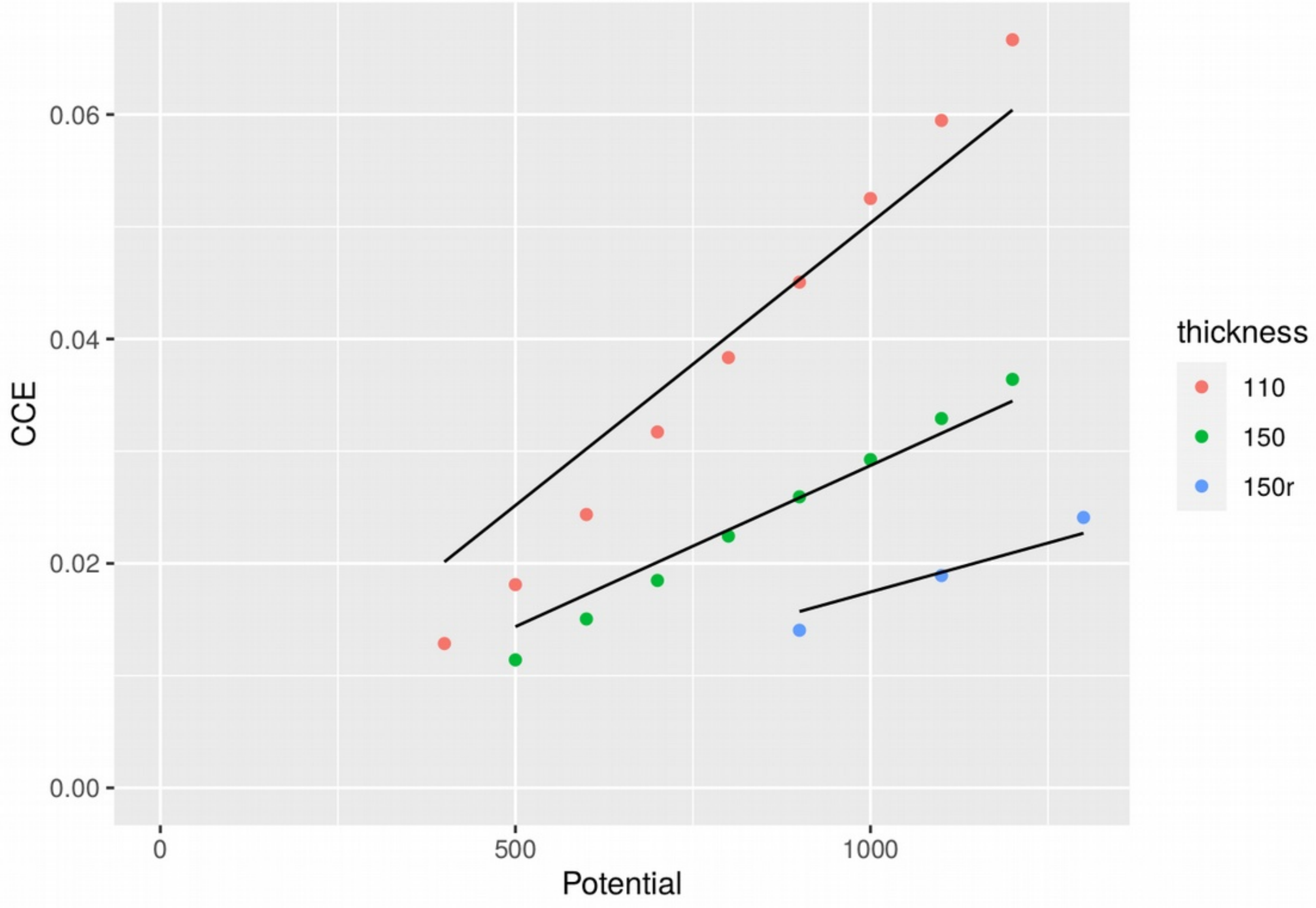
Results: CCE



Results: mu x tau

- Points do not align on a straight line from the origin as foreseen by the Hecht equation

- $\mu\tau = 6.09 \, x \, 10^{-9} \ \ cm^2/V$ for 110 um sapphire
  $\mu\tau = 6.46 \, x \, 10^{-9} \ \ cm^2/V$ for 150 um sapphire
  $\mu\tau = 3.93 \, x \, 10^{-9} \ \ cm^2/V$ for 150 um sapphire reversed voltage

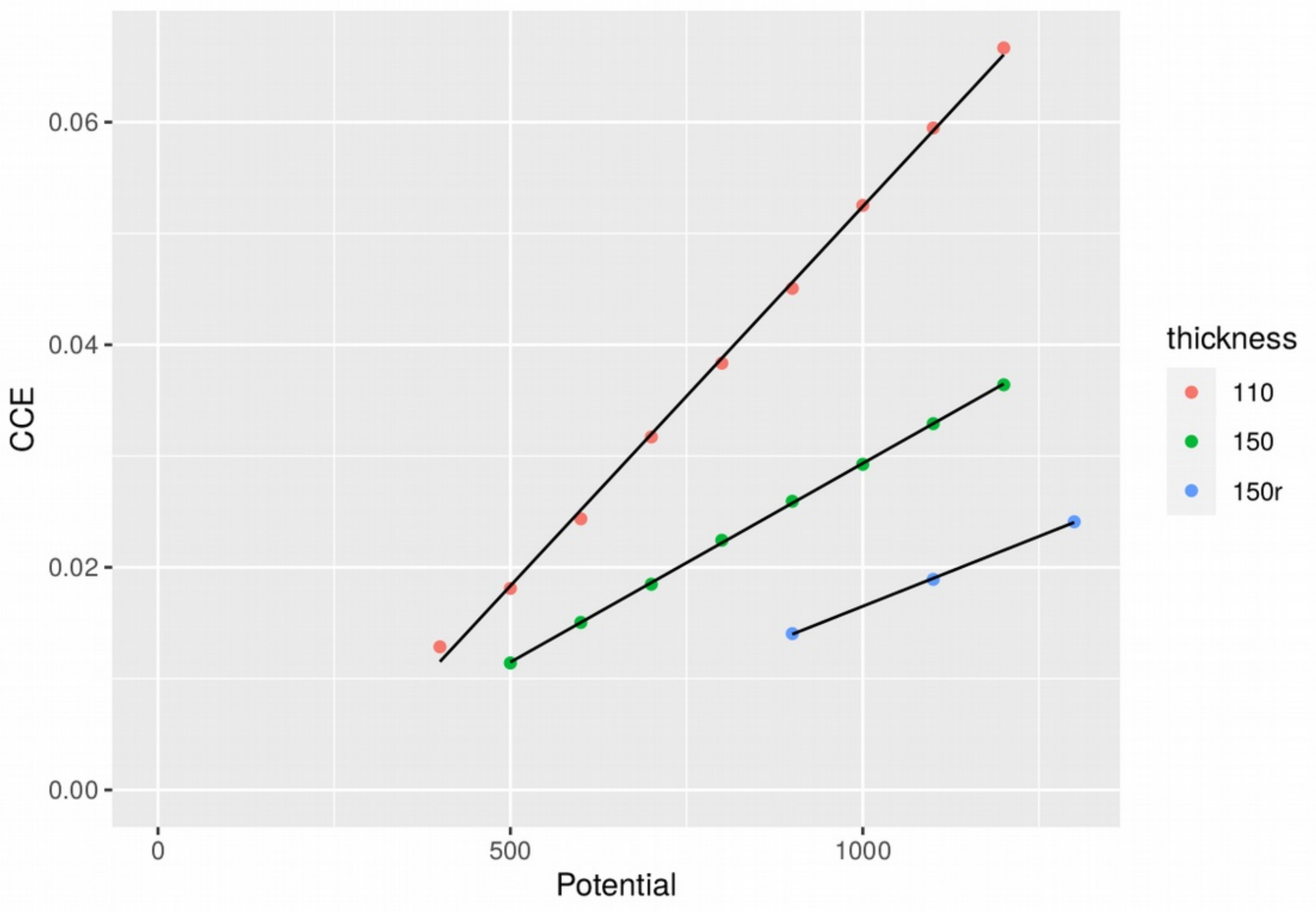


Results: mu x tau

- Fitting for:
  $CCE = CCE_0 + k(1-\exp(-1/k))$
- one obtains:

  $\mu\tau = 8.25\,x\,10^{-9}\ \mathrm{cm}^2/\mathrm{V}$
  $CCE_0 = -1.57\,\%$
  for 110 um sapphire
  $\mu\tau = 8.04\,x\,10^{-9}\ \mathrm{cm}^2/\mathrm{V}$
  $CCE_0 = -0.64\,\%$
  for 150 um sapphire
  $\mu\tau = 5.65\,x\,10^{-9}\ \mathrm{cm}^2/\mathrm{V}$
  $CCE_0 = -0.86\,\%$
  for 150 um sapphire - reversed bias

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



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