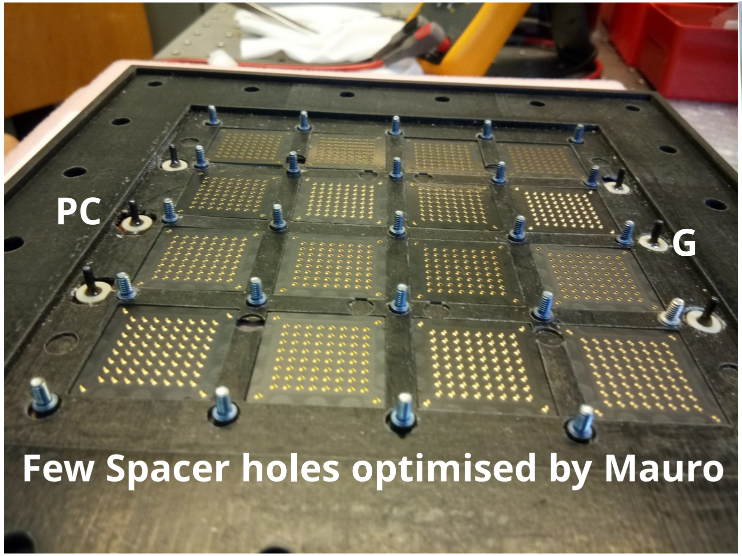
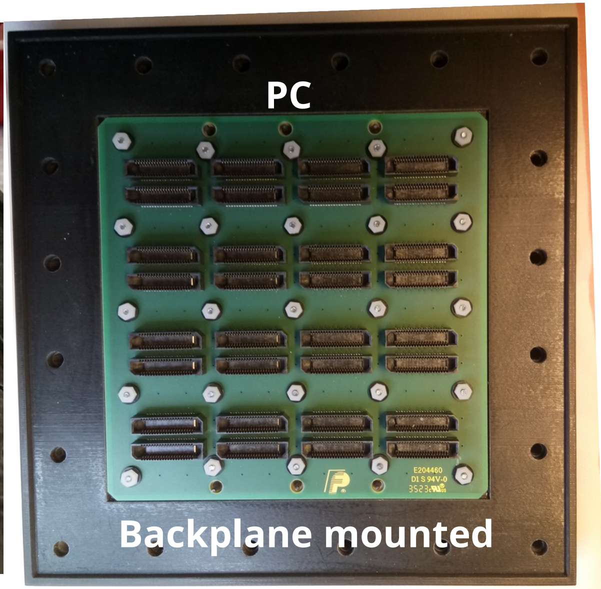
Preliminary tests performed on HRPPD #25

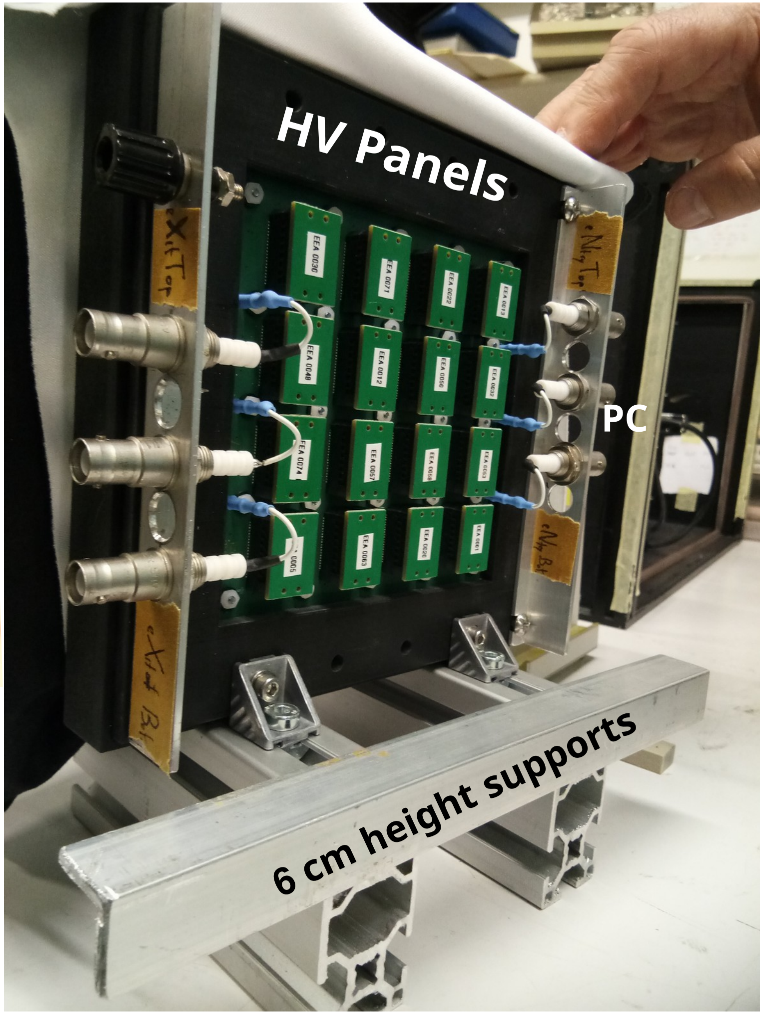
Fulvio, Jinky

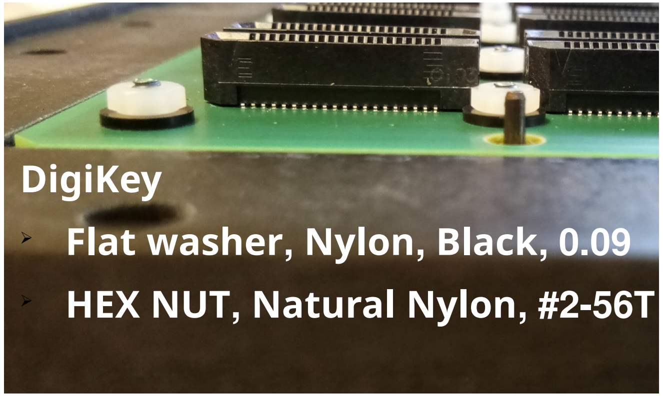
13/02/2025

Assembling









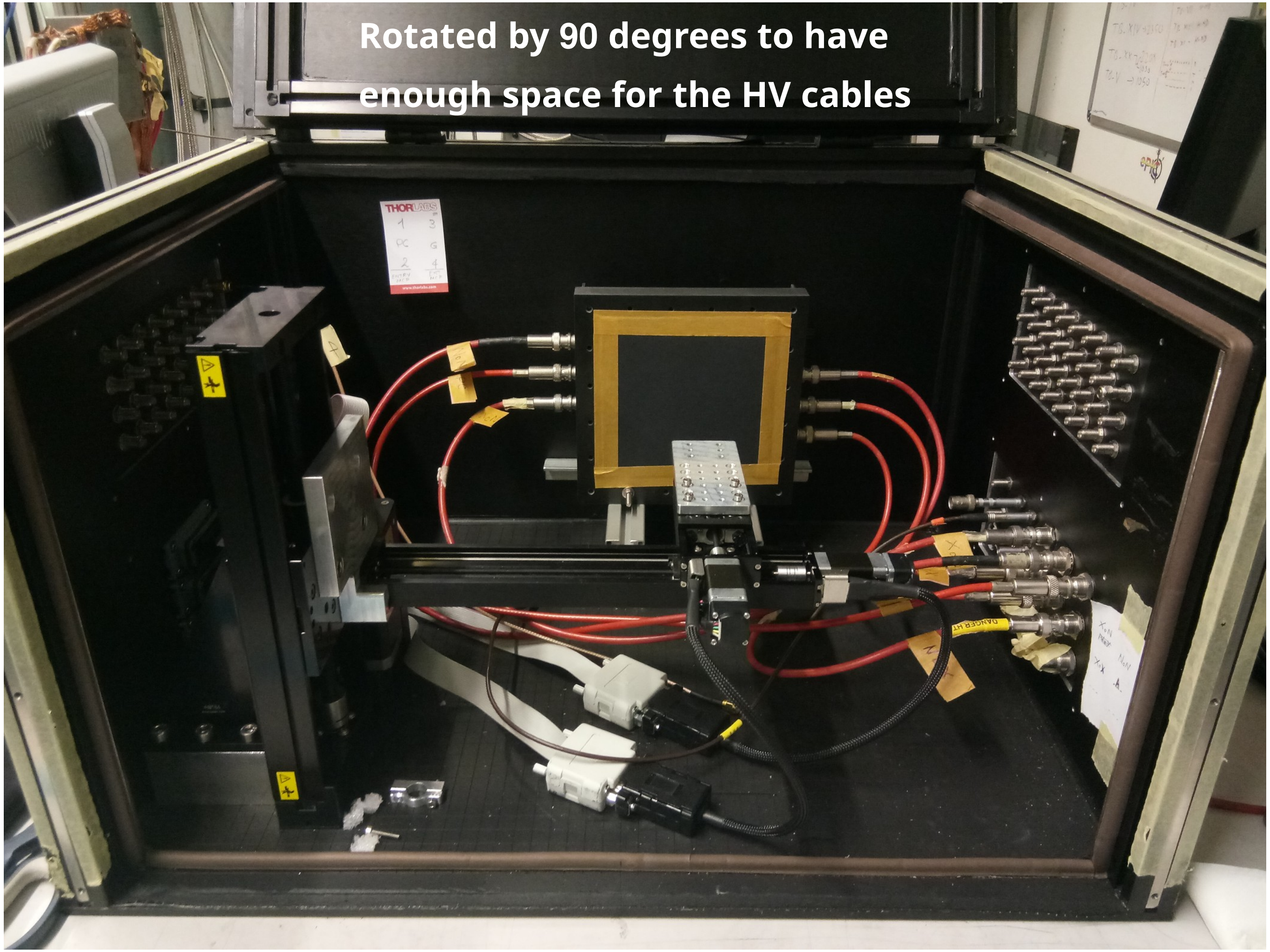
Planarity O (100 µm)
~100 µm bump – top to bottom

HRPPD N.25 inside dark box

Electrode mapping
inside dark box
<u>Front view</u>

NoN	HRPPD N.25	NoX
PC		G
XoN		XoX

- HV cabling
- Preliminary tests performed



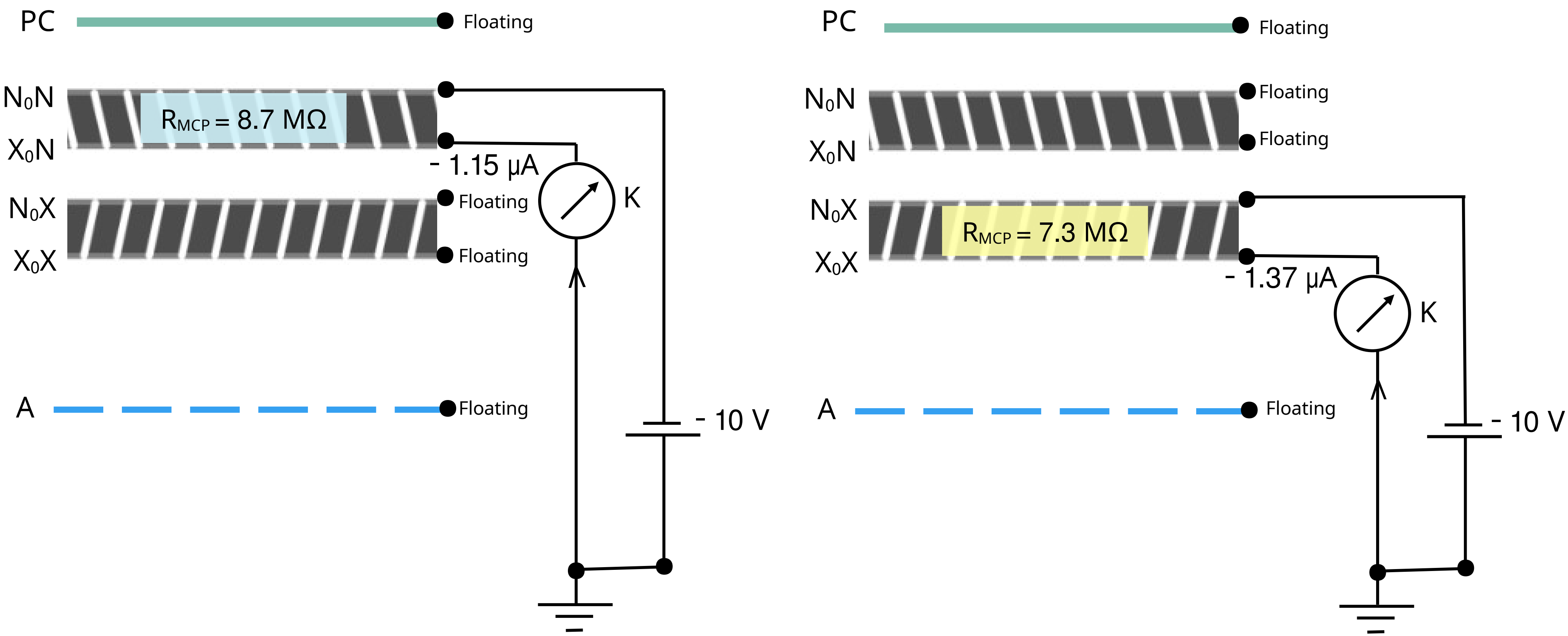
Equipments

- HRPPD N.25 inside dark box
- CAEN DT1415ET HV Power Supply
- Two Keithley 6485 models
- Custom-designed Pico-Ammeters (PA20, PA60, PA100, PA120 etc.), calibrated, offset values noted down

  - **Circuits are NOT to scale**
  - Our tests are mostly with 10 to 200 V
  - ROP (Incom): 200-700-200-700-200 V (all -ve values)

Resistance of MCPs

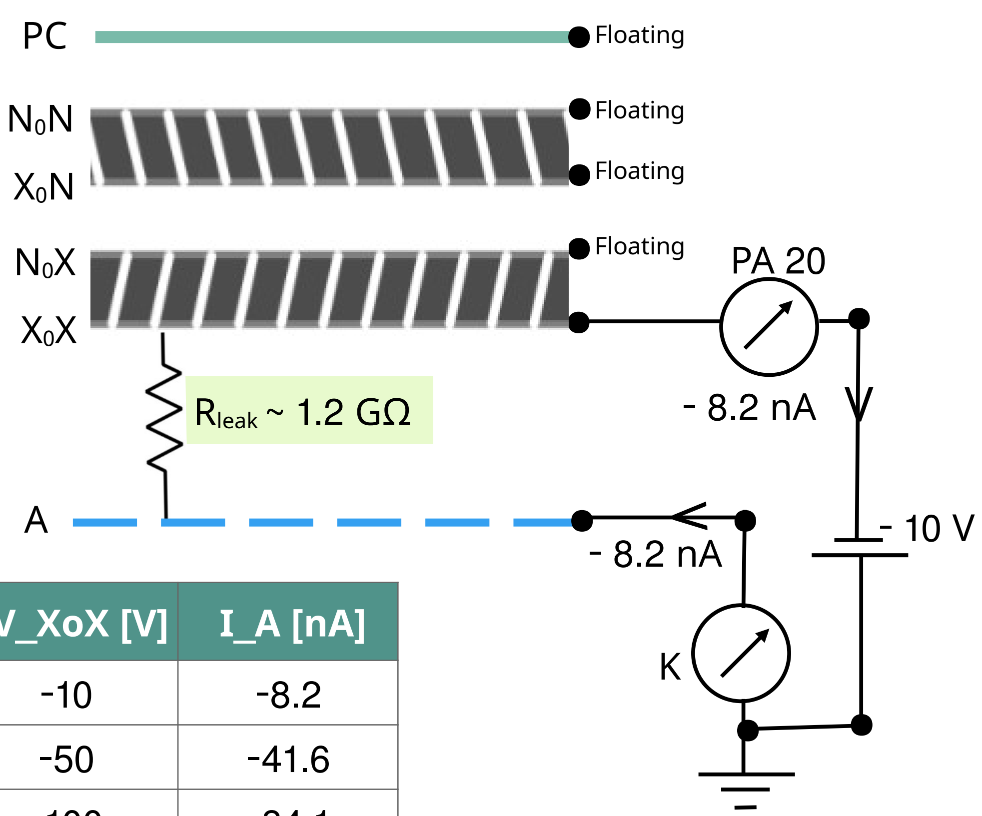
Circuits are NOT to scale



- The Entry MCP shows higher R at low ΔV than that of the Exit MCP
- Test report (by Incom) provides: 7.2/6.0 MΩ for Entry/Exit MCP at 800 V

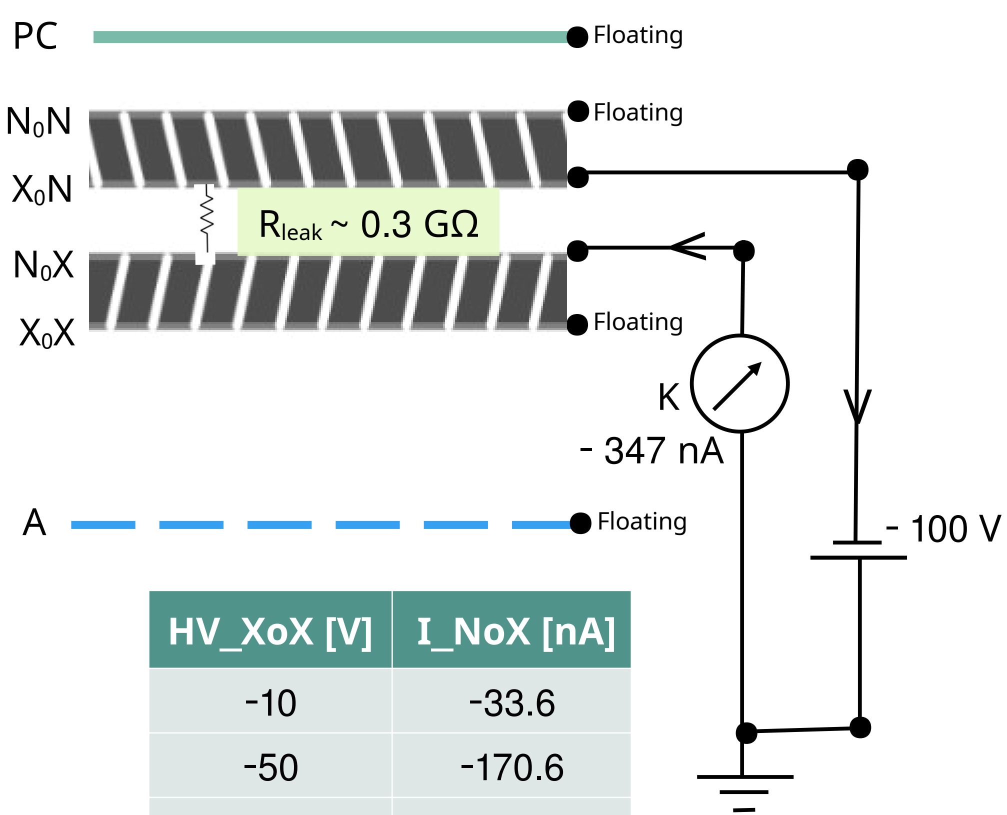
Measurement of Leaks

Measurement of Leaks



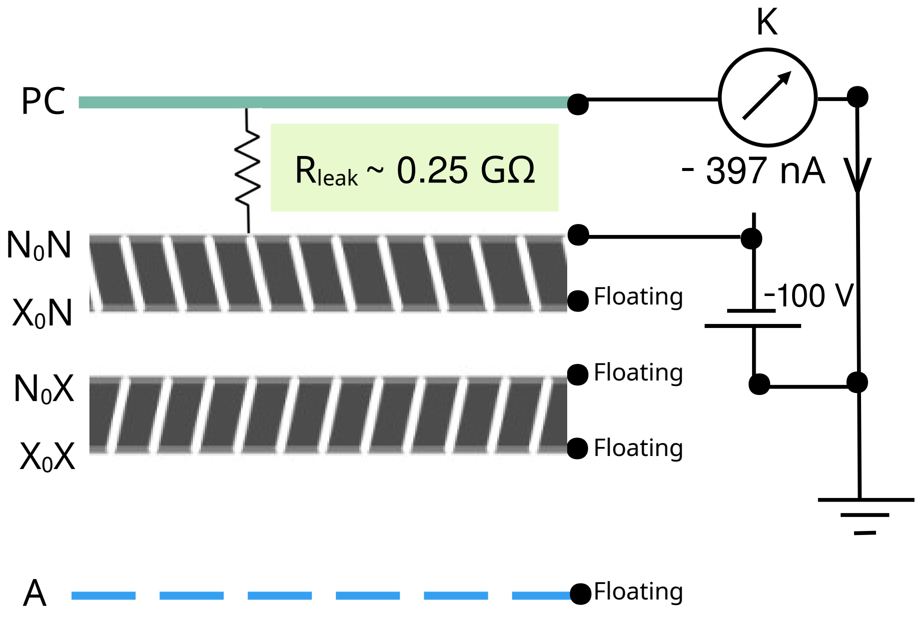
HV_XoX [V]	I_A [nA]
-10	-8.2
-50	-41.6
-100	-84.1
-200	-170.5

Same currents measured when
- PA20 removed.
- A and XoX swapped.



HV_XoX [V]	I_NoX [nA]
-10	-33.6
-50	-170.6
-100	-347
-200	-711

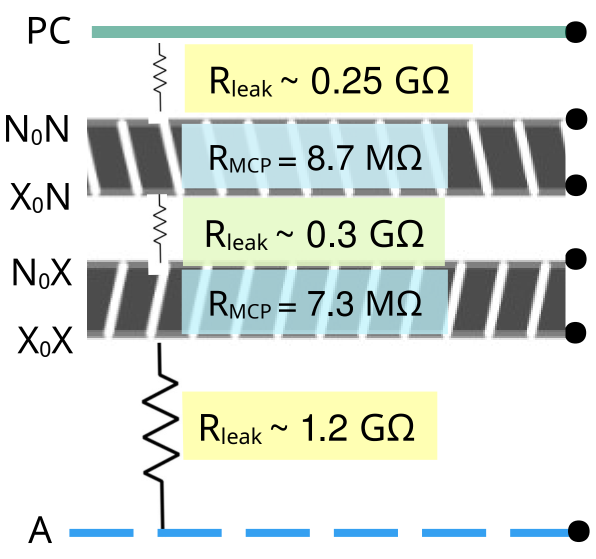
Measurement of Leaks

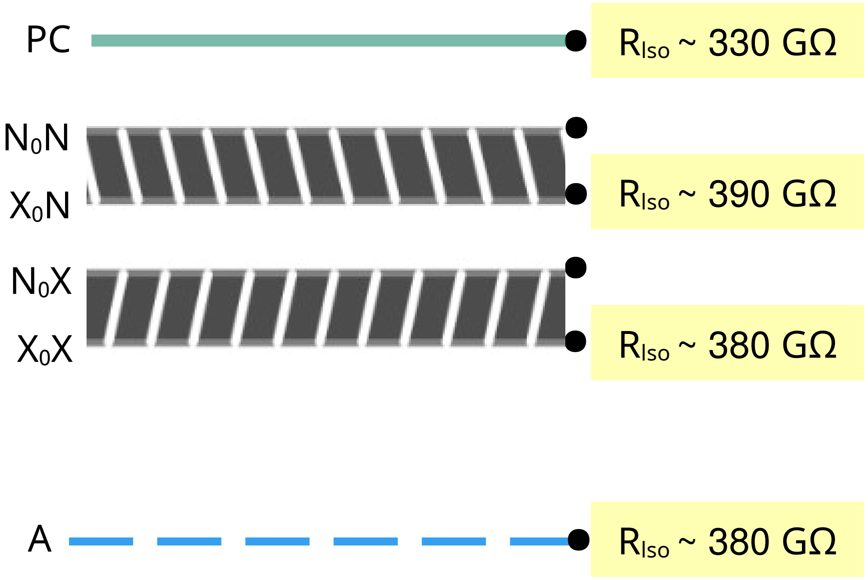


HV_NoN [V]	I_PC [nA]
-10	-38.9
-50	-197
-100	-397

Good linearity.

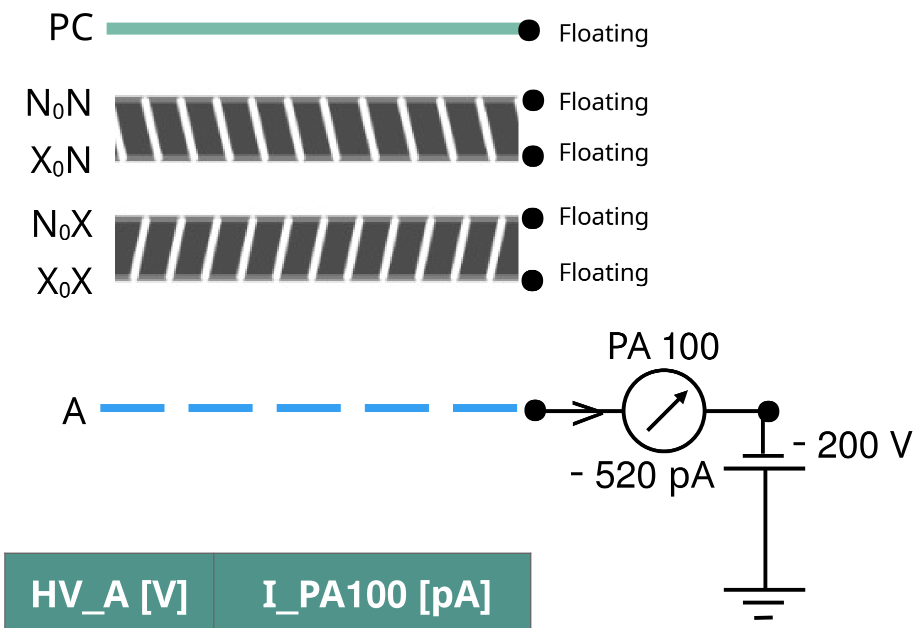
Measurement of Leaks/Isolation





Measurement of Isolation

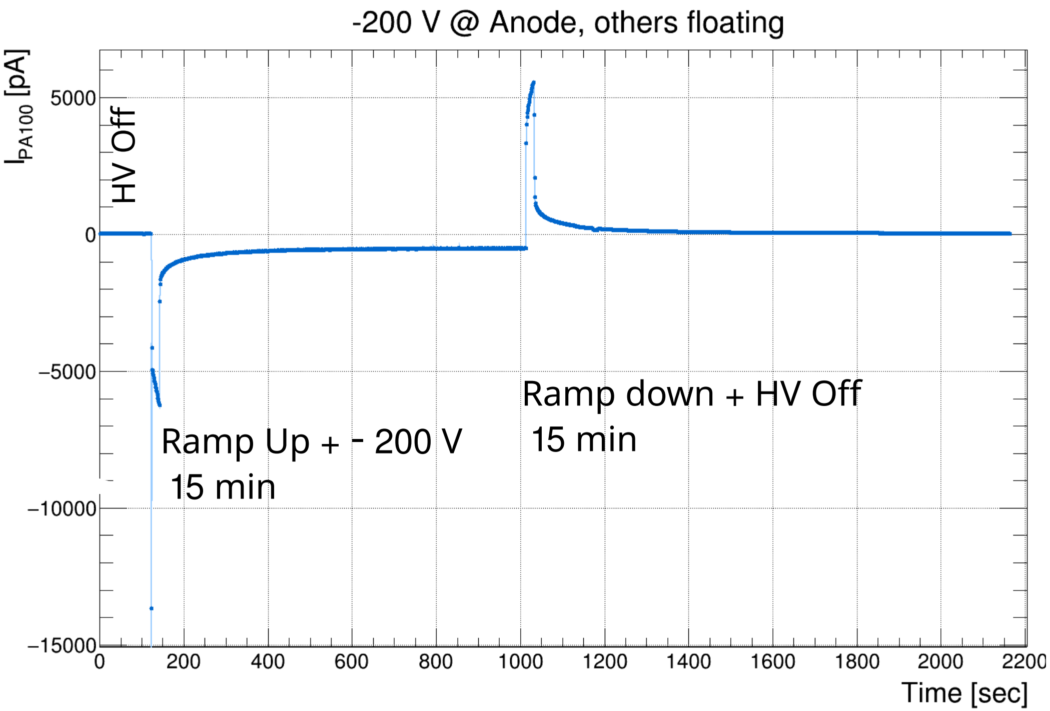
Isolation tests

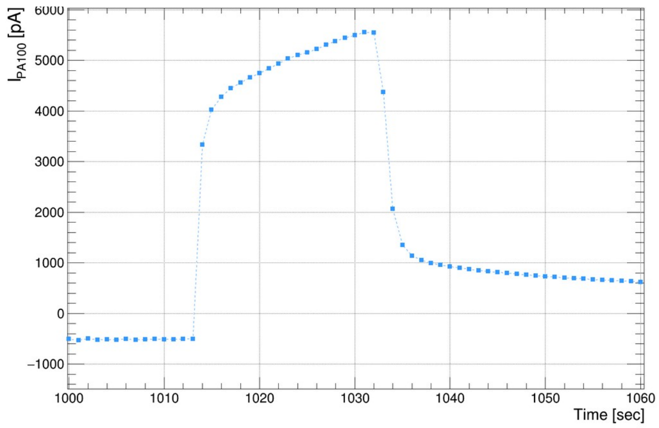


HV_A [V]	I_PA100 [pA]
-10	-20
-20	-40
-100	-250
-200	-520

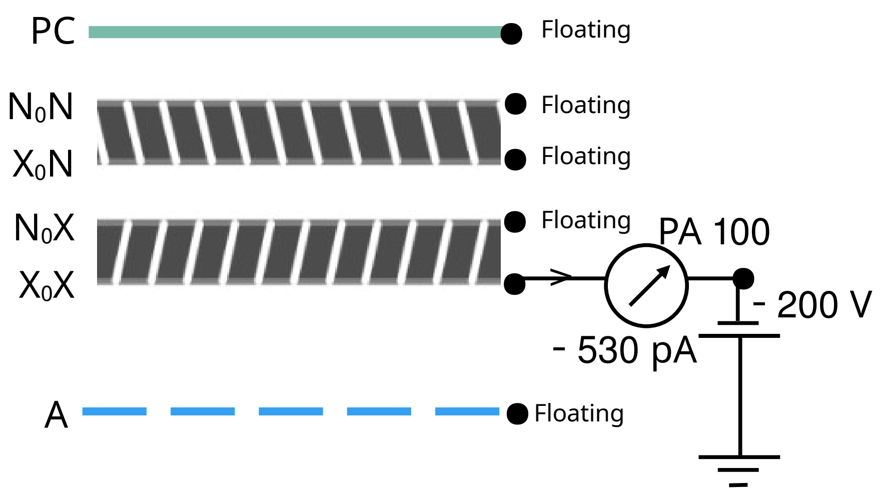
$R_{A,iso}$ ~ 350-400 GΩ

Ohmic?

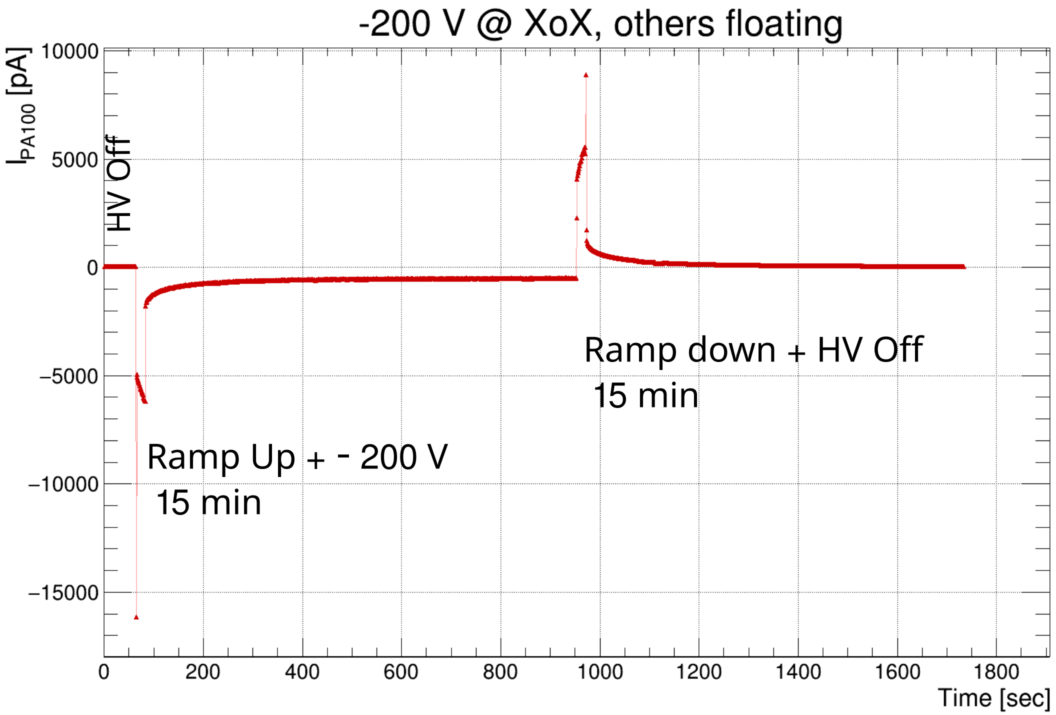


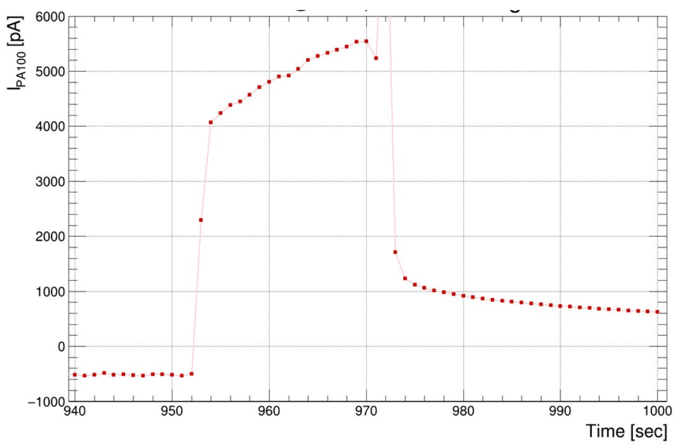


Isolation tests

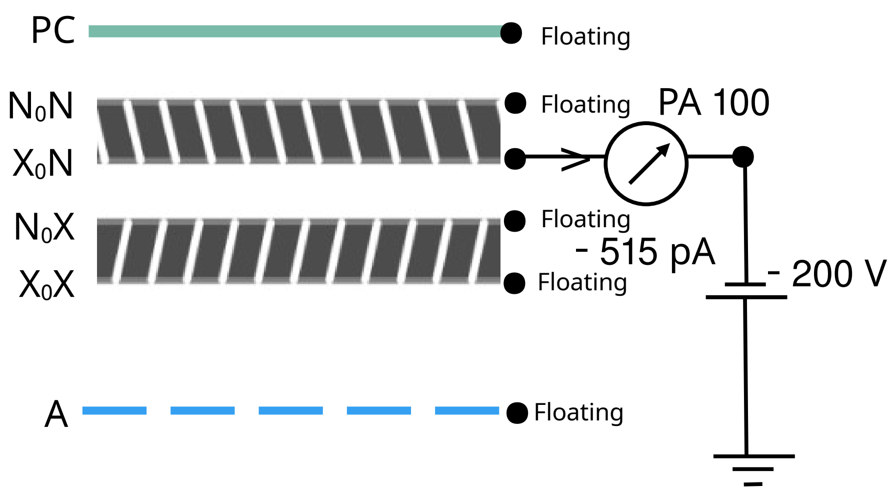


$R_{XoX,\ iso} \sim 380\ G\Omega$

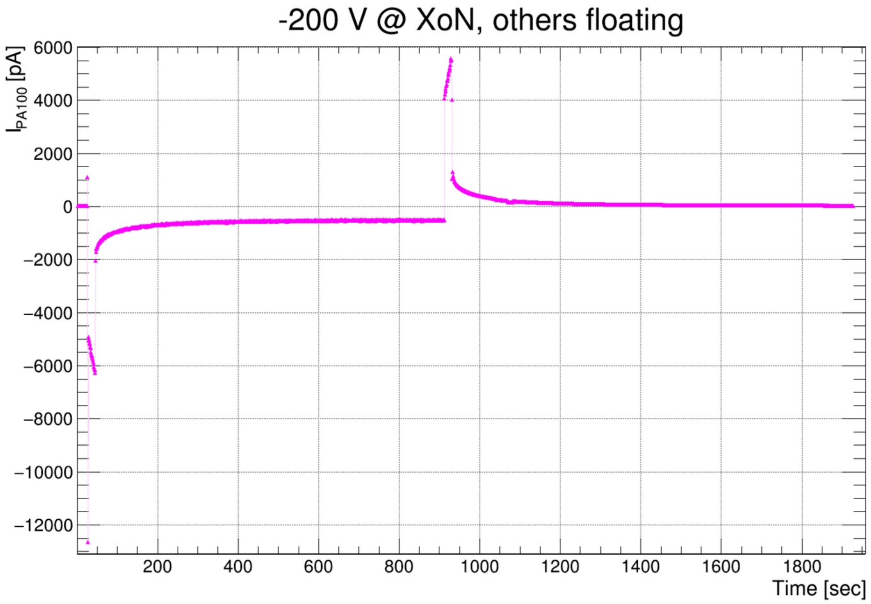


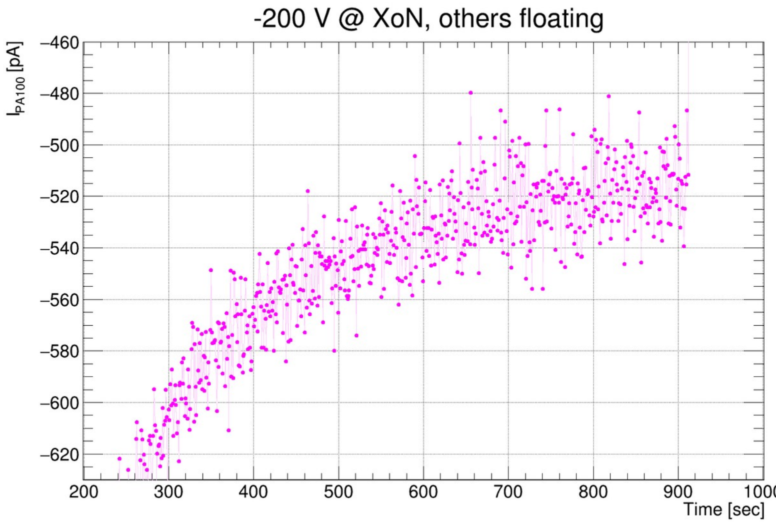


Isolation tests

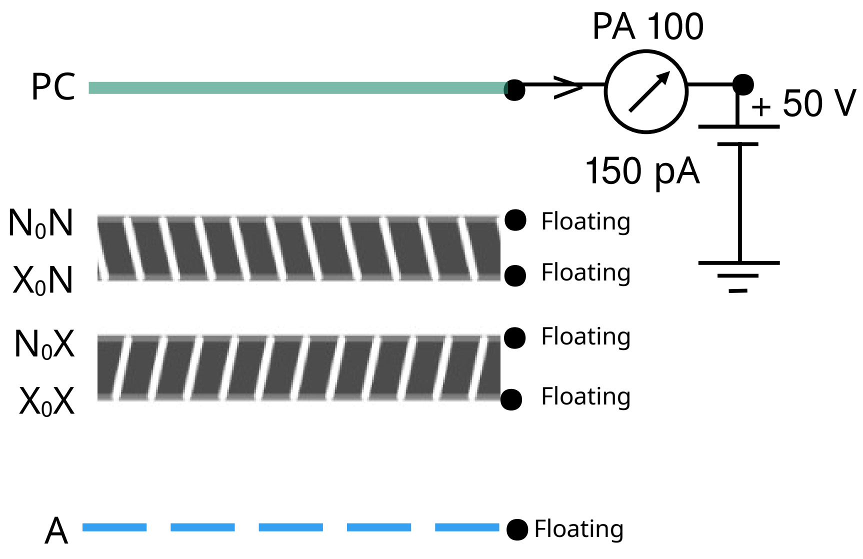


$R_{XoN,\, iso} \sim 390\ G\Omega$

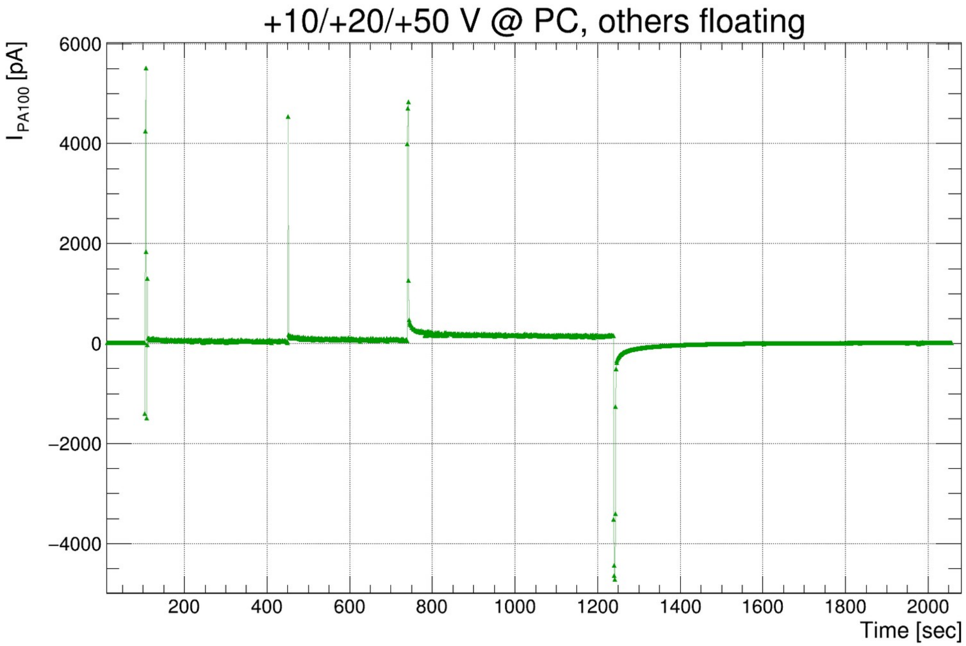


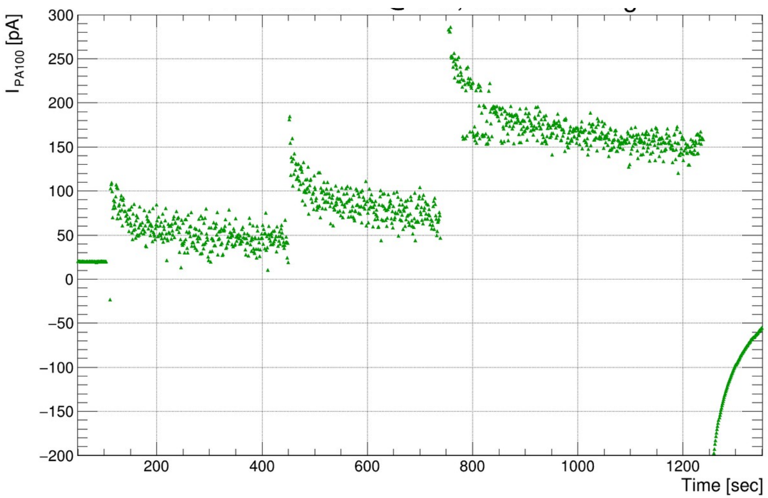


Isolation tests



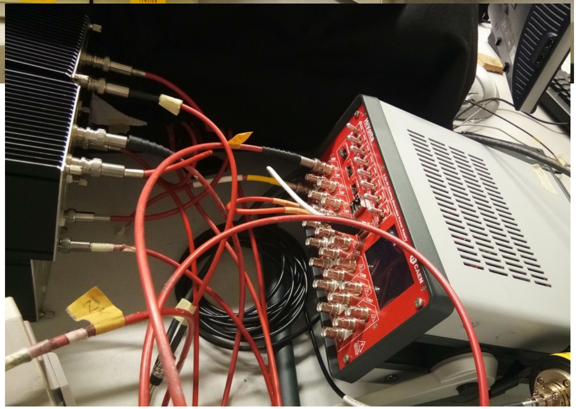
$R_{PC,\ iso} \sim 330\ G\Omega$





Anode @ CAEN HV, others @ ground

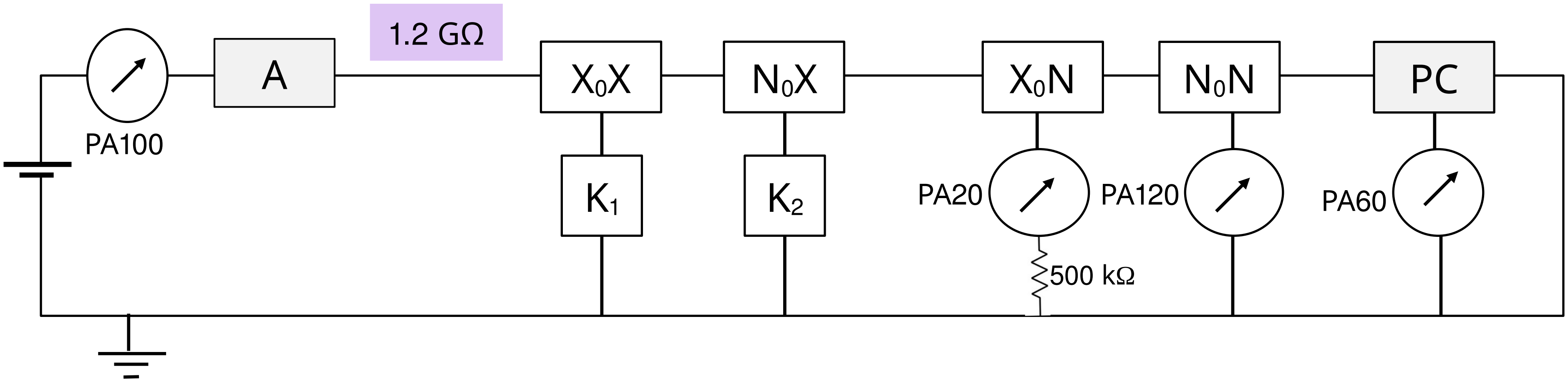
- Two Keithley
- Each of the four PA channels was inserted between a detector electrode and ground



vplot program
Recording of data

Anode @ CAEN HV, others @ ground

This test is performed for having more clarity on Leaks

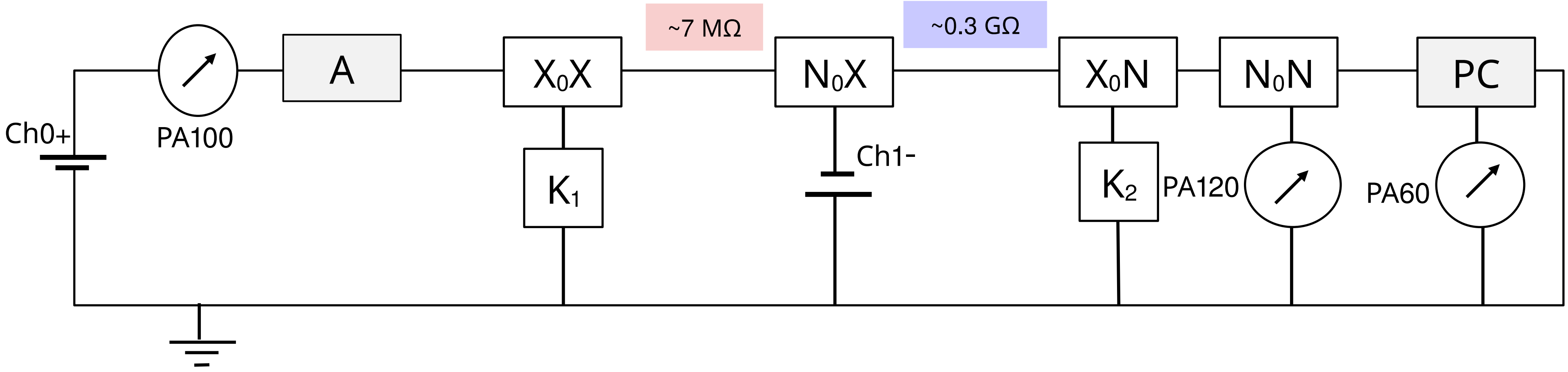


HV [V]	PA100 [nA]	K1 [nA]	K2 [pA]	PA20 [pA]	PA120 [pA]	PA60 [pA]
+ 10	8.3	8.2	-1	31	27	15
+ 20	16.6	16.5	-0.5	35	30	25
+ 30	25.0	24.8	+5	39	33	30

- Good linearity. PA100 and K1 confirm 1.2 GΩ Ohmic leak between A and XoX.
- K2 reads zero.
- PA channels provide Offset values.

Anode, NoX @ CAEN HV, others @ ground

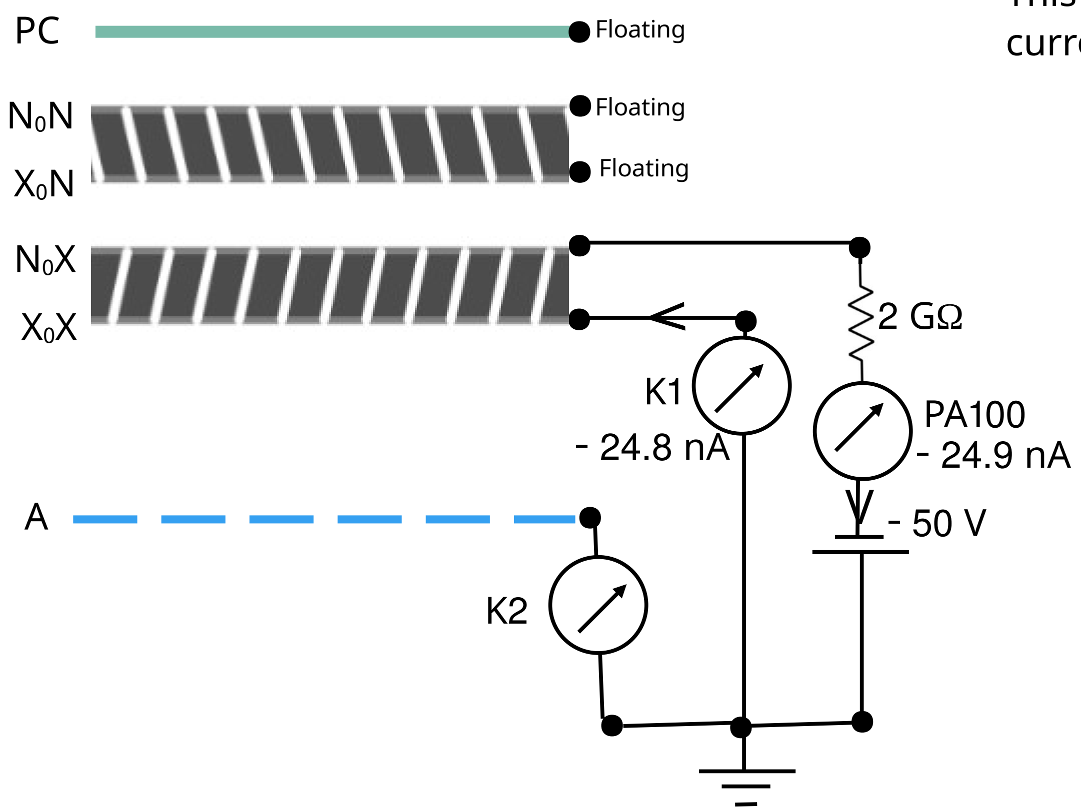
This test is performed for having more clarity on Leaks



HV Ch0+ [V]	HV Ch1+ [V]	PA100 [pA]	K1 [µA]	K2 [nA]	PA120 [pA]	PA60 [pA]
Off	-10	0	-1.35	-35	16	0
Off	-20	0	-2.7	-70	-20	2
Off	-50	28	-6.9	-176	-102	0
Off	-100	46	-14	-357	-240	-5

- K1 values confirm ~ 7 MΩ of Exit MCP.
- K2 values confirm 0.3 GΩ between two MCPs.
- PA channels read -ve currents.

I_{CAEN} vs. I_K

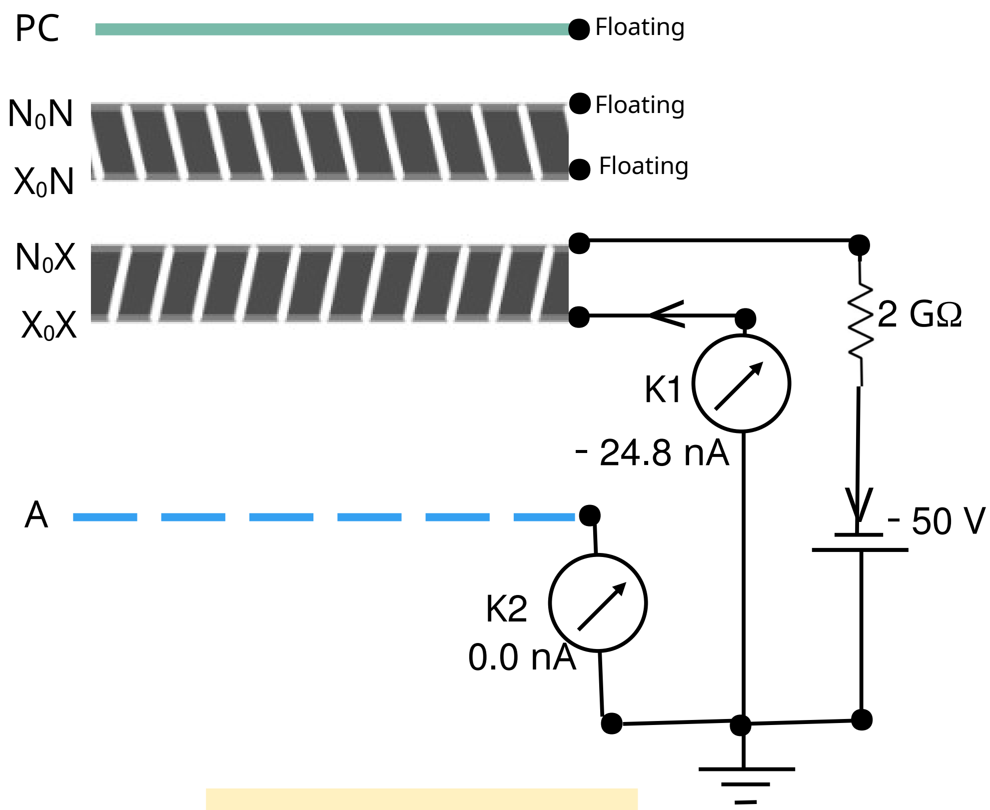


This test is performed to check the reliability of CAEN currents when nominal potential is applied

HV [V]	I_caen [nA]	PA100 [nA]	K1 [nA]	K2
0	-24.4	-0.01	-0.02	0
- 10	-16.3	-5.0	-5.0	0
- 20	-7.3	-9.97	-9.95	0
- 50	4.8	-24.9	-24.8	0

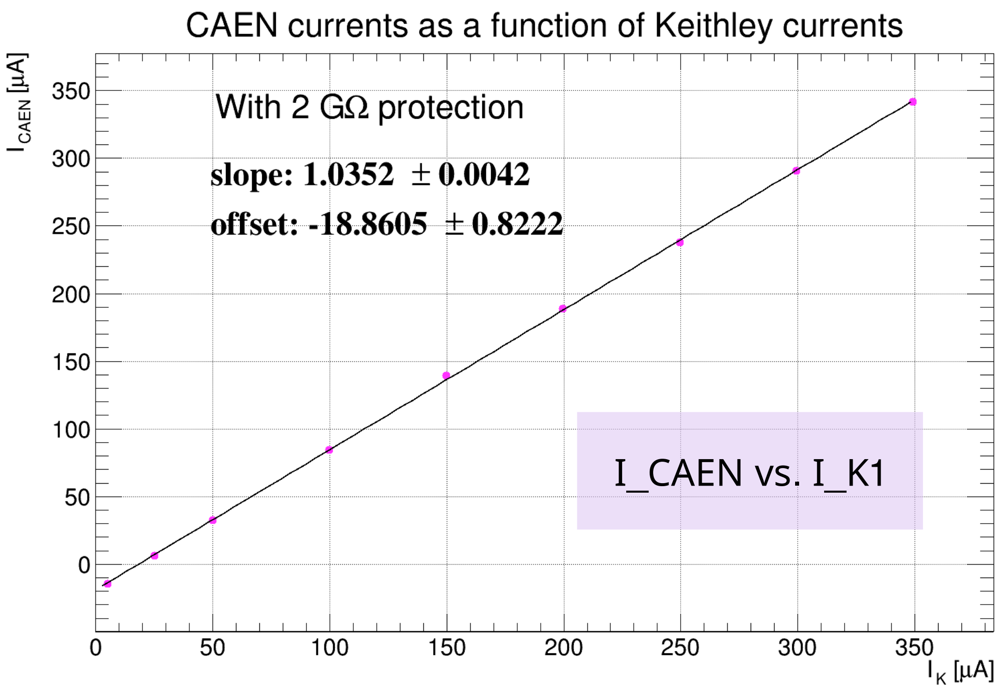
- K1 and PA100 read the same value, whereas CAEN reads different values
- In next step we removed PA100

I_{CAEN} vs. I_K



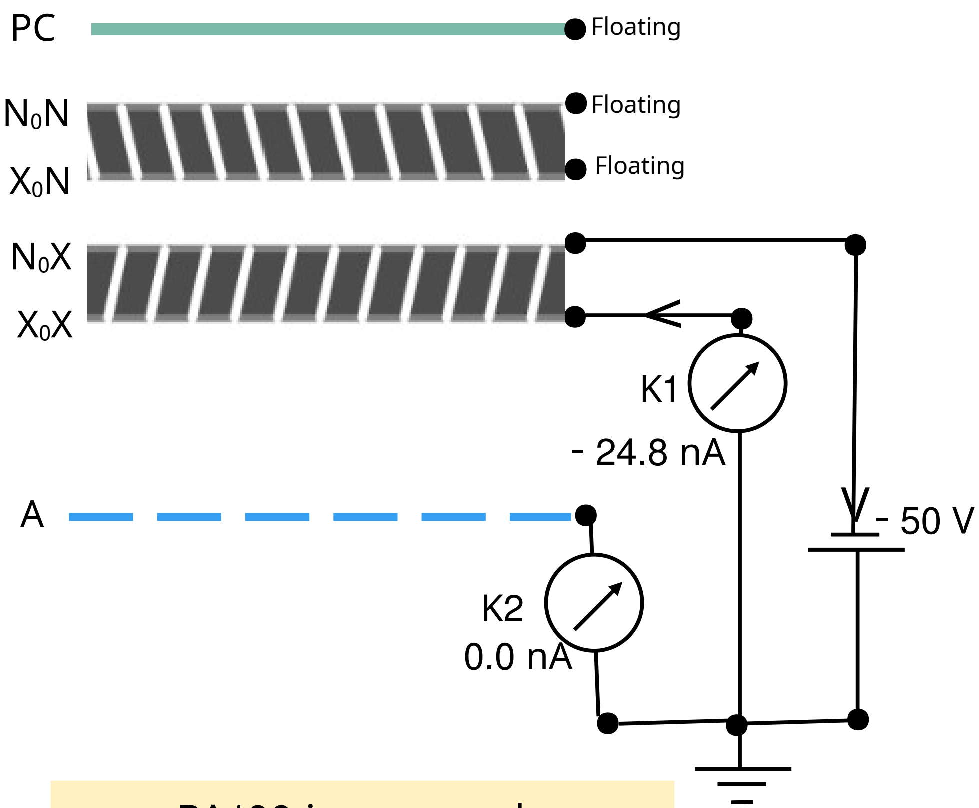
PA100 is removed

This test is performed to check the reliability of CAEN currents when nominal potential is applied



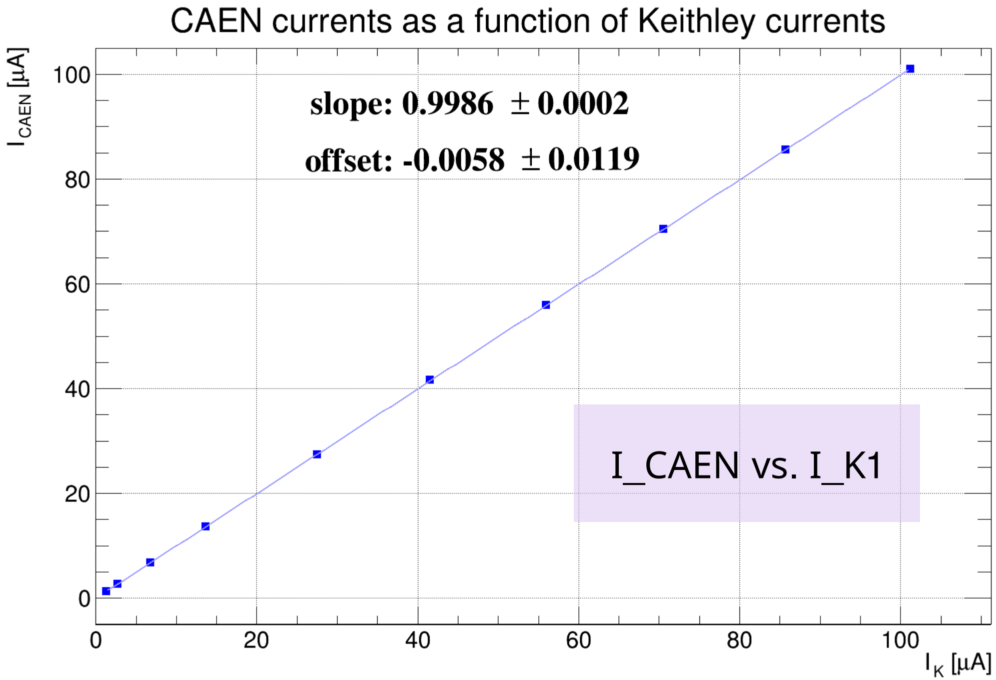
- For 10, 50 100, 200, 300, 400, 500, 600, 700 V

I_{CAEN} vs. I_K



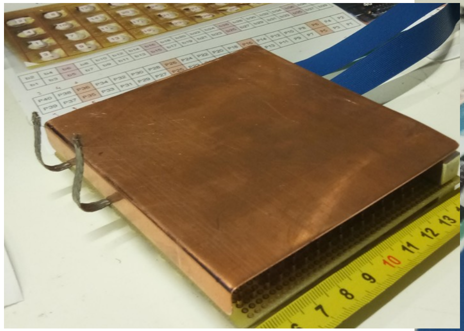
PA100 is removed.
2 GΩ protection is removed.

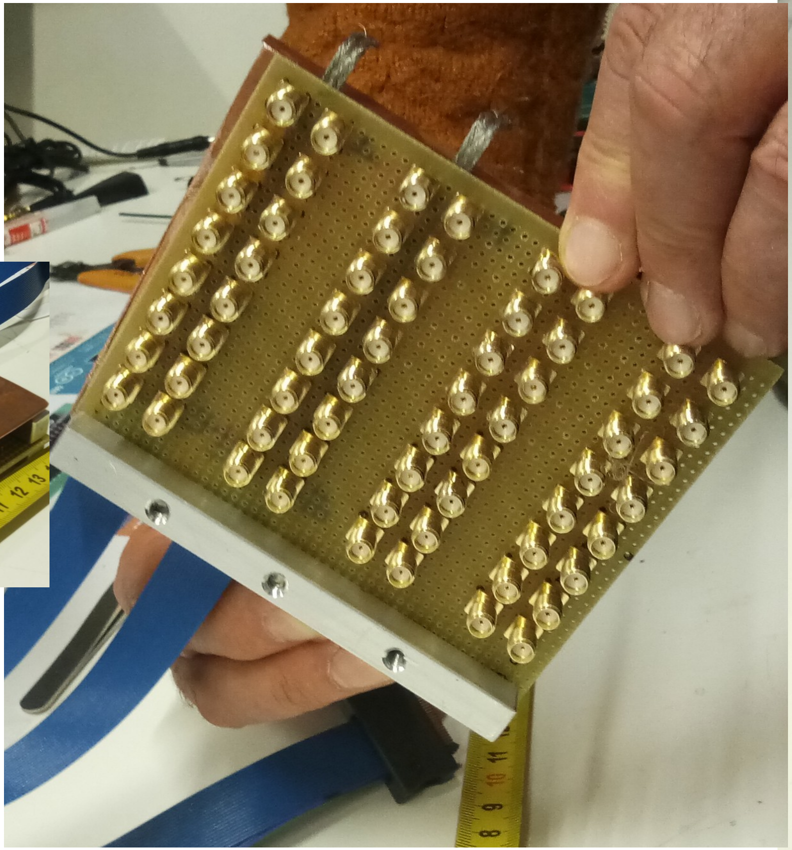
This test is performed to check the reliability of CAEN currents when nominal potential is applied

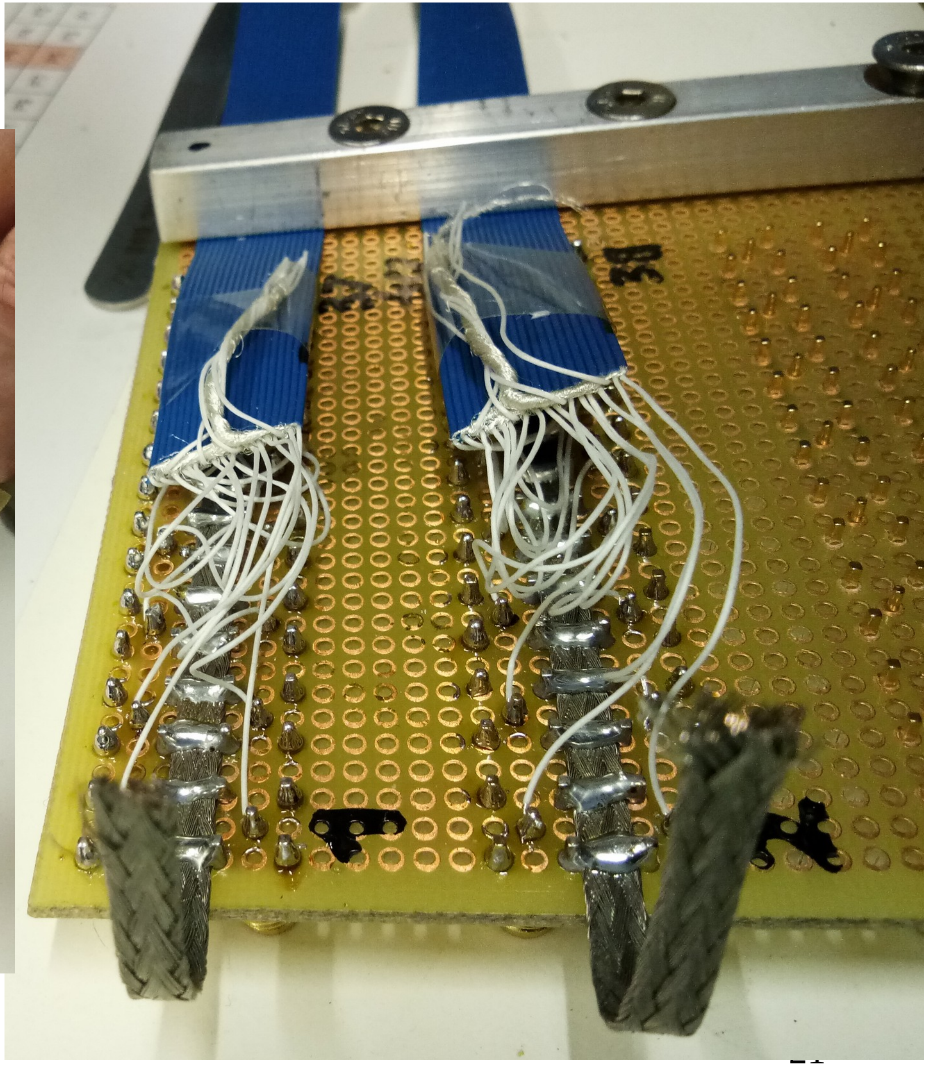


- For 10, 50 100, 200, 300, 400, 500, 600, 700 V

Mauro’s bread board - updates







- Reading of **64 pads** from a group using 4 flat cables.
- Grounding of 32 Pads together.

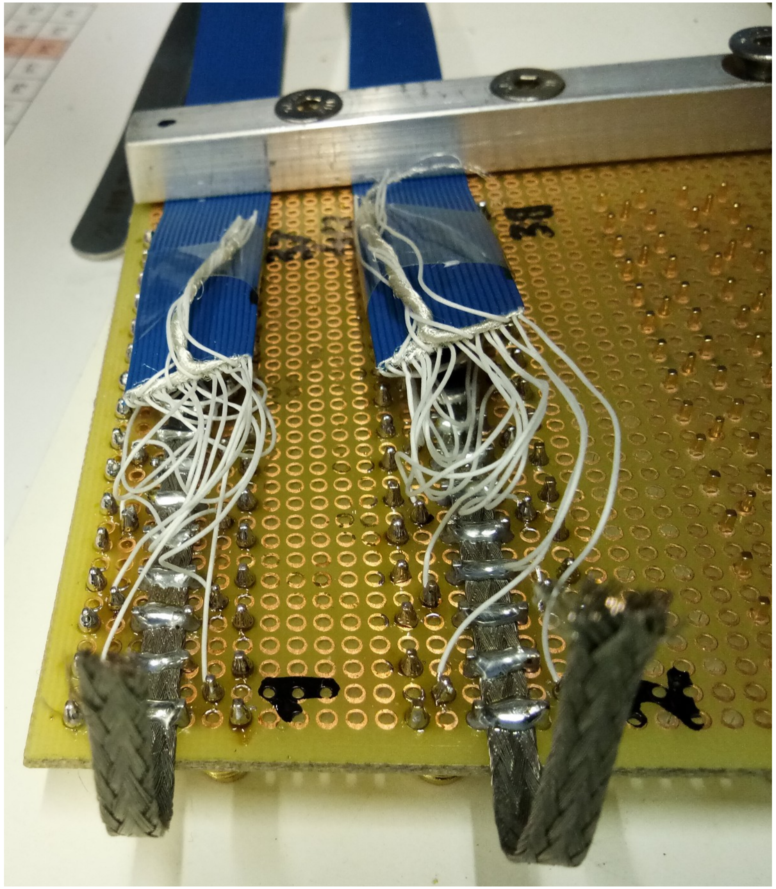
Updates on HRPPD N.25 activities

Jinky

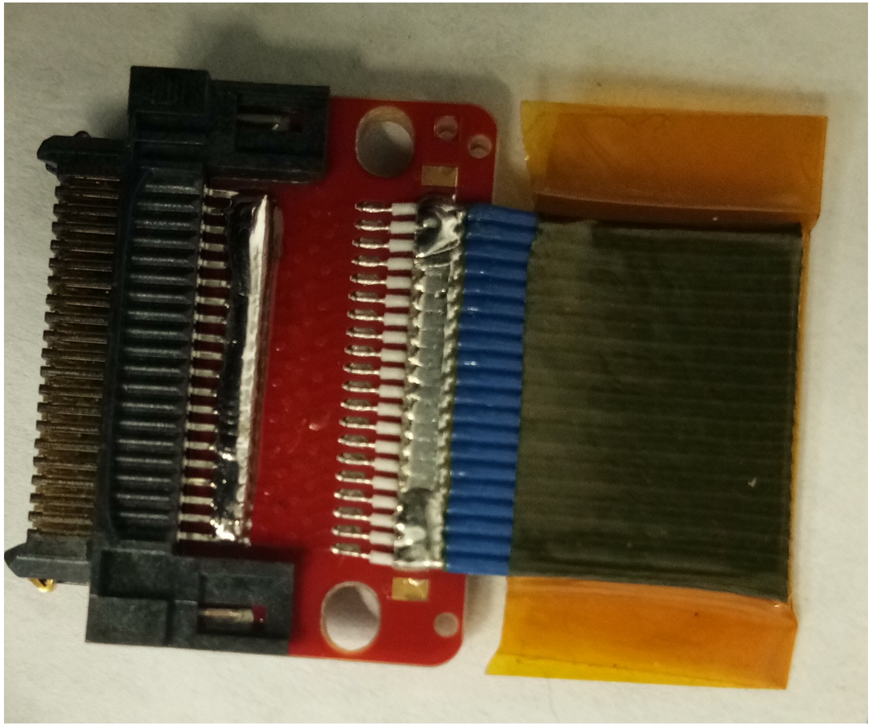
18/02/2025

Mauro’s bread board - updates

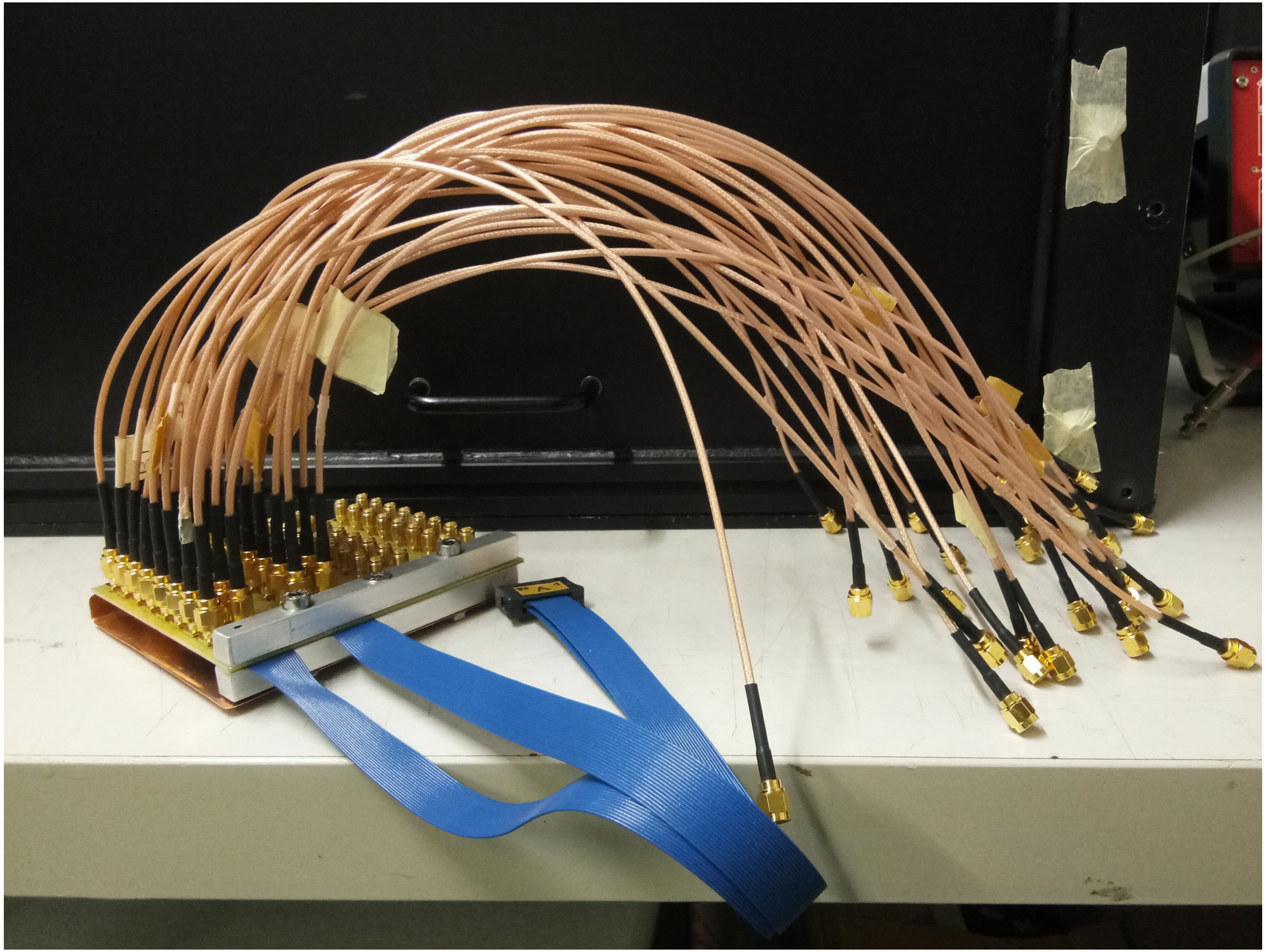
32 readout channels



Grounding: 32 channels



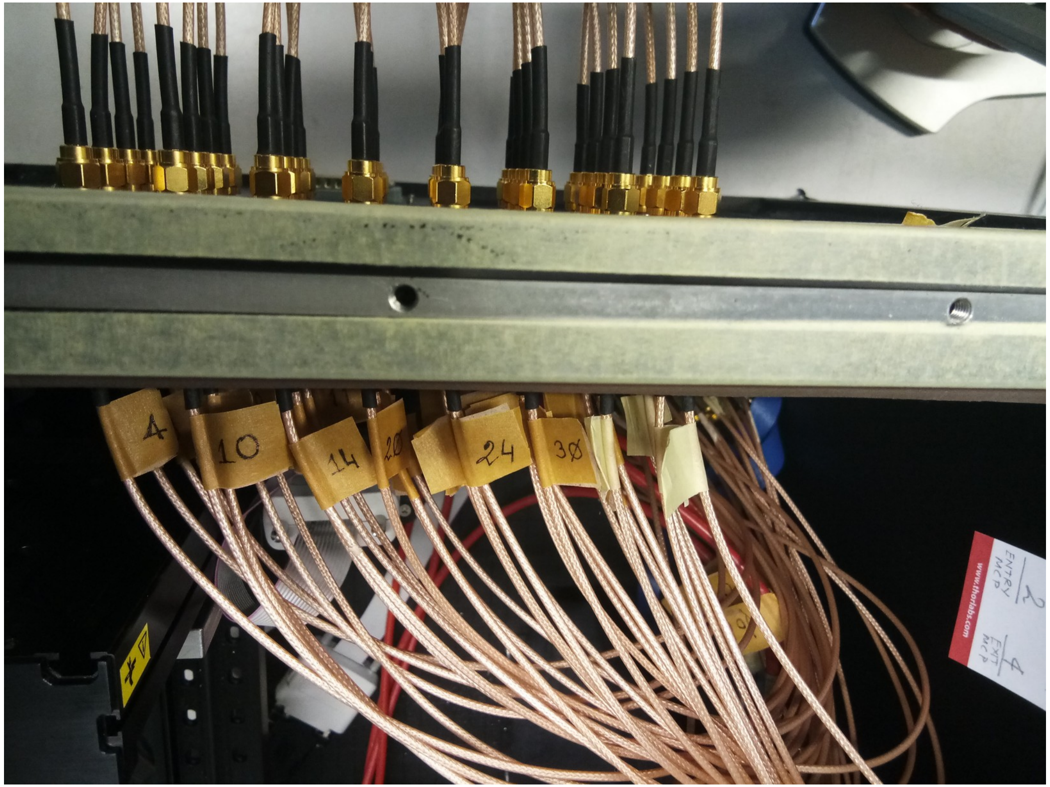
Readout preparation

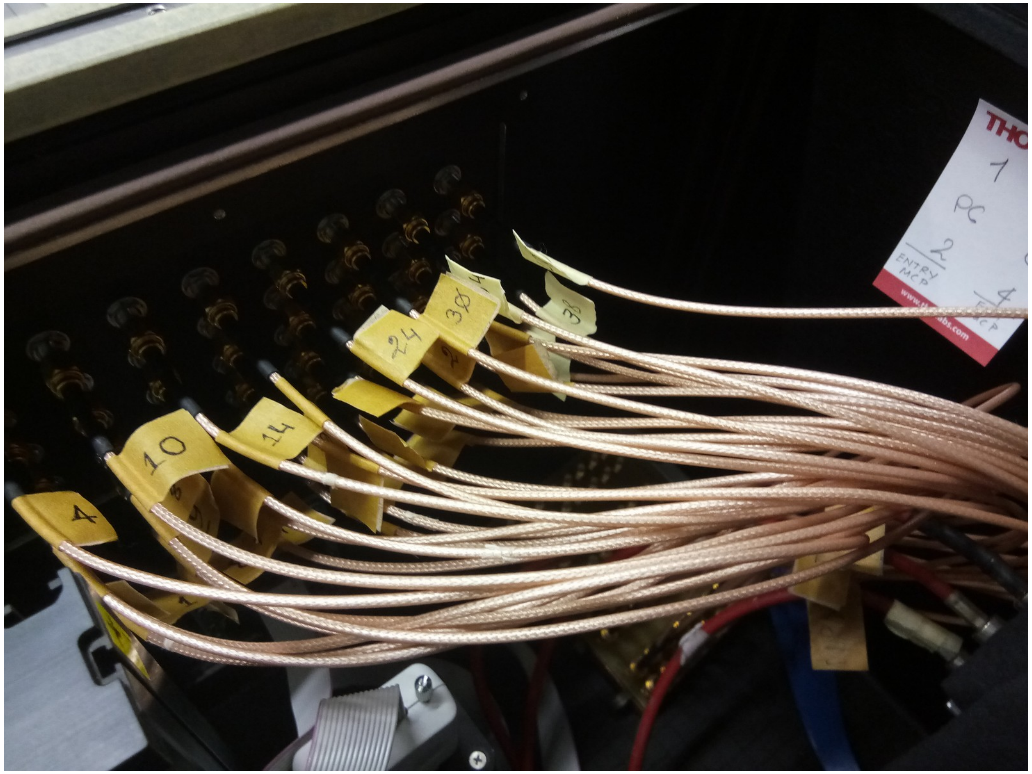


Breadboard (32 RO channels)
- Prepared
- Connections checked
- Cabling with labeling done

Readout preparation

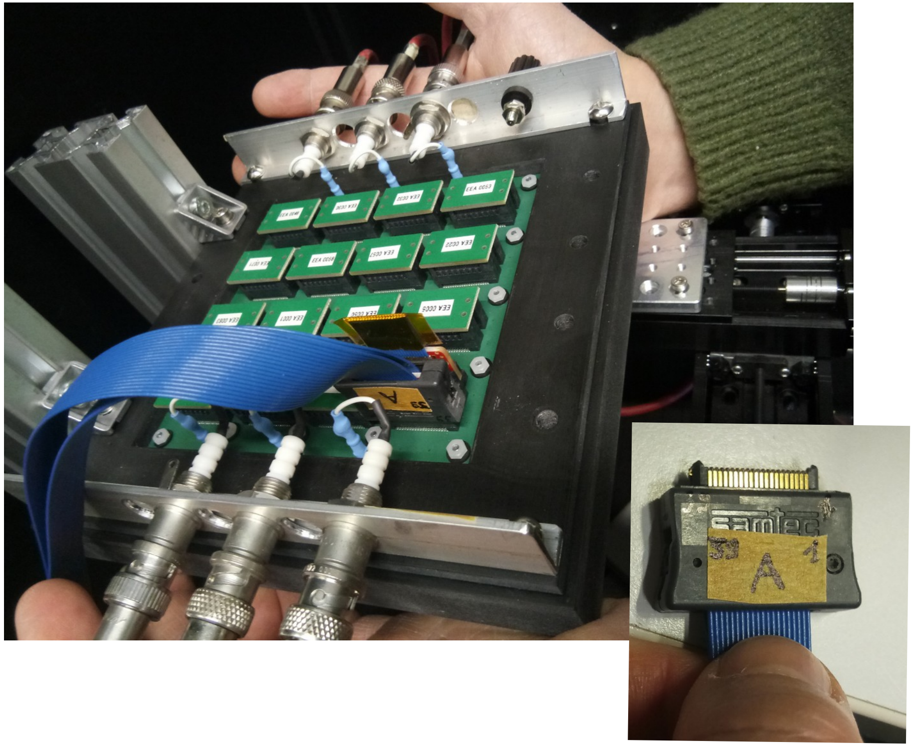
Cabling and labeling done at the patch panel, both inside and outside of the dark box

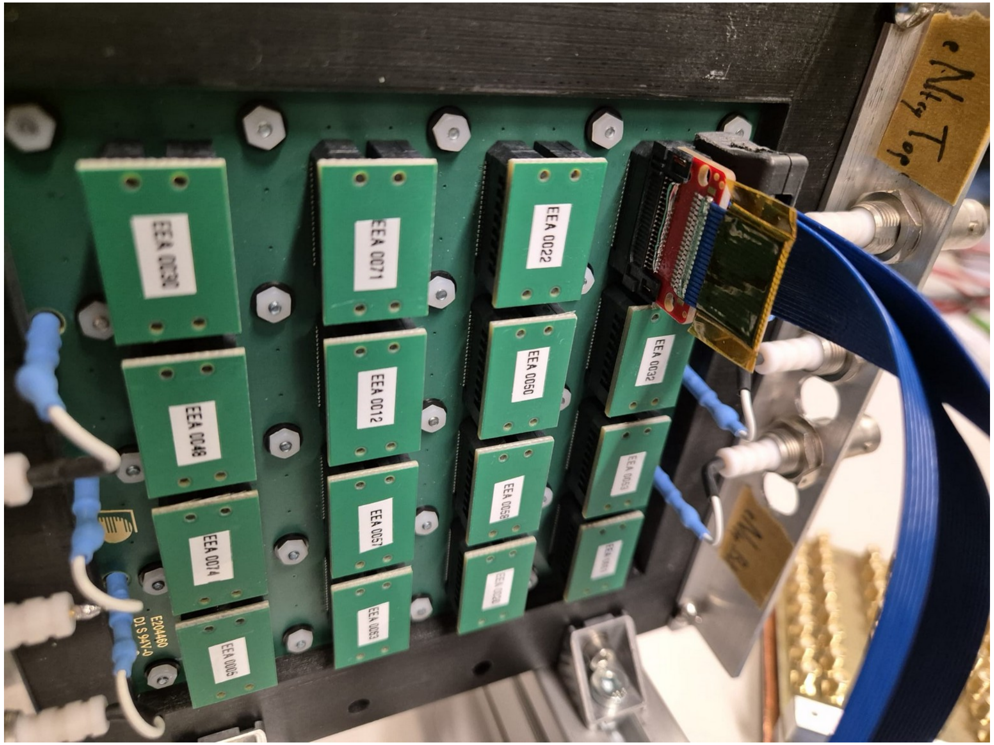




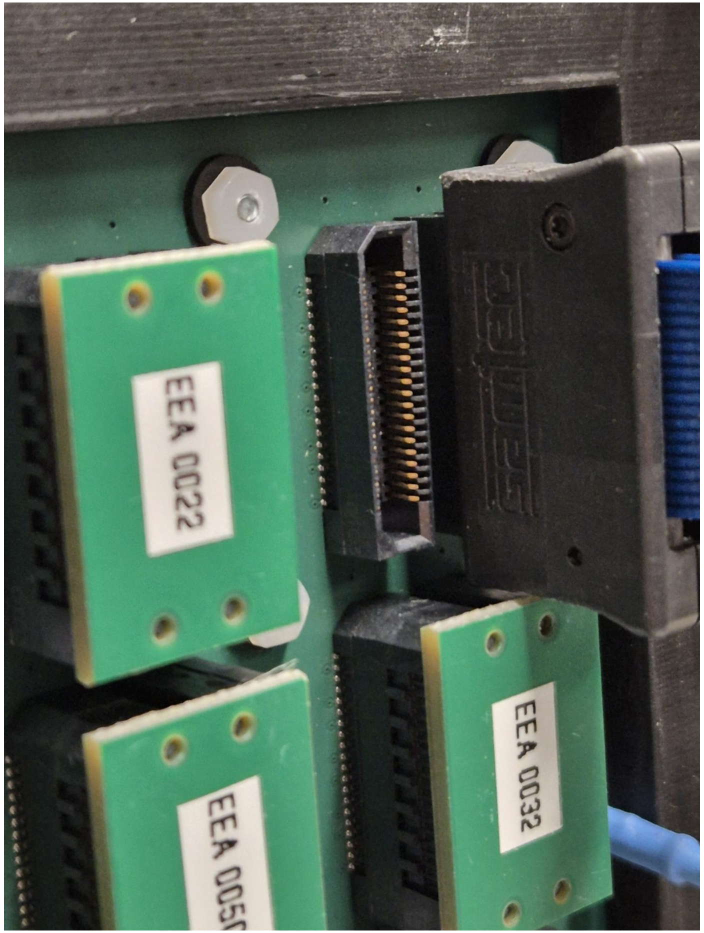
µ-Coax cables plugged in

- Reading Group D0 top 32 pads (near NoN connector)
- Labeling done





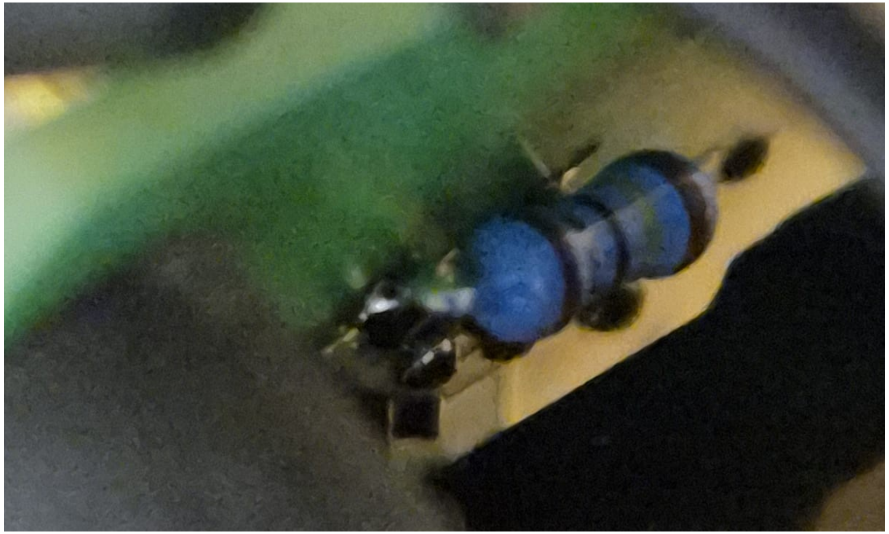
μ-Coax cables plugged in

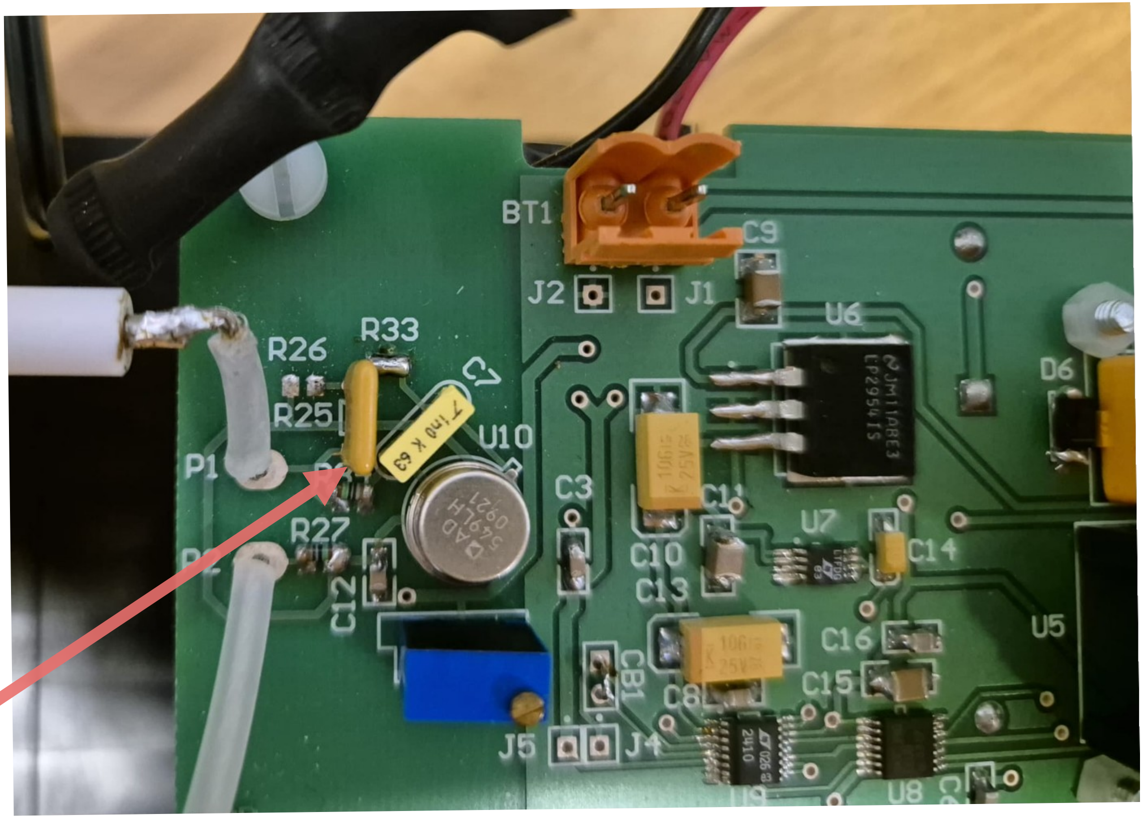


Plastic of the connector reduced

Modification of PA100

1 MΩ added in parallel to the 10 MΩ

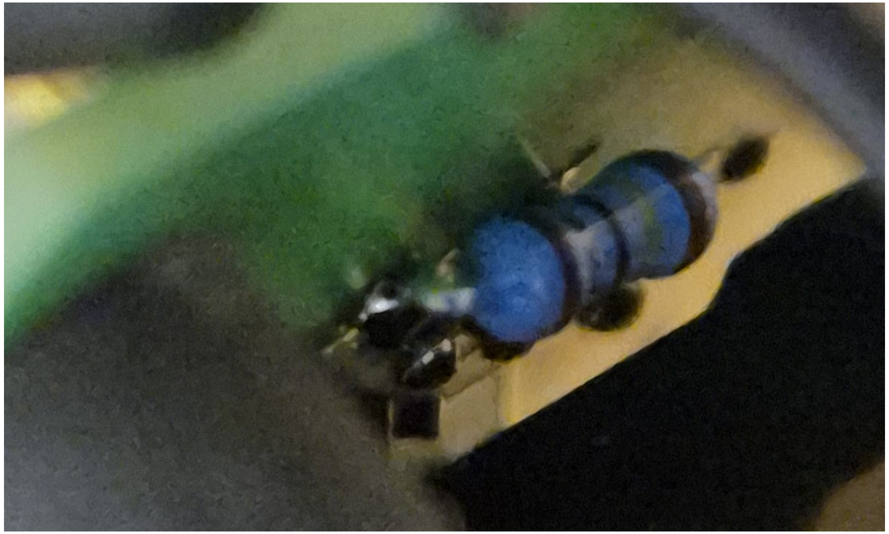




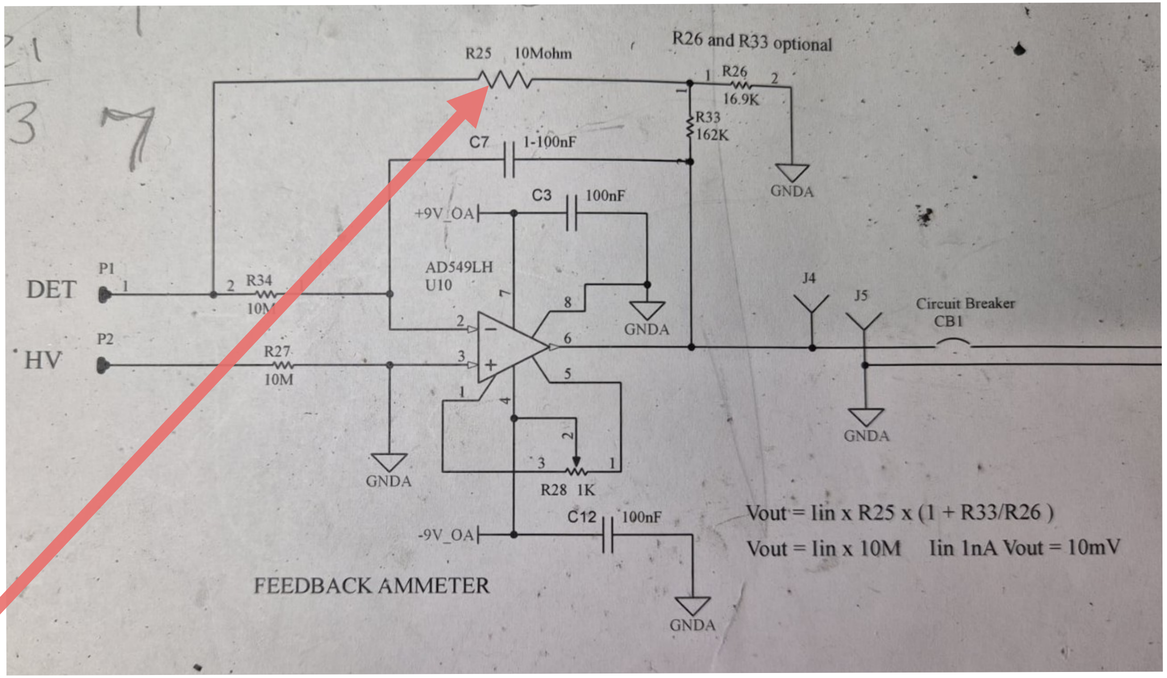
R25

Modification of PA100

1 MΩ added in parallel to the 10 MΩ



Maximum current for 10 MΩ: 46 nA
Maximum current for PA100: 500 nA



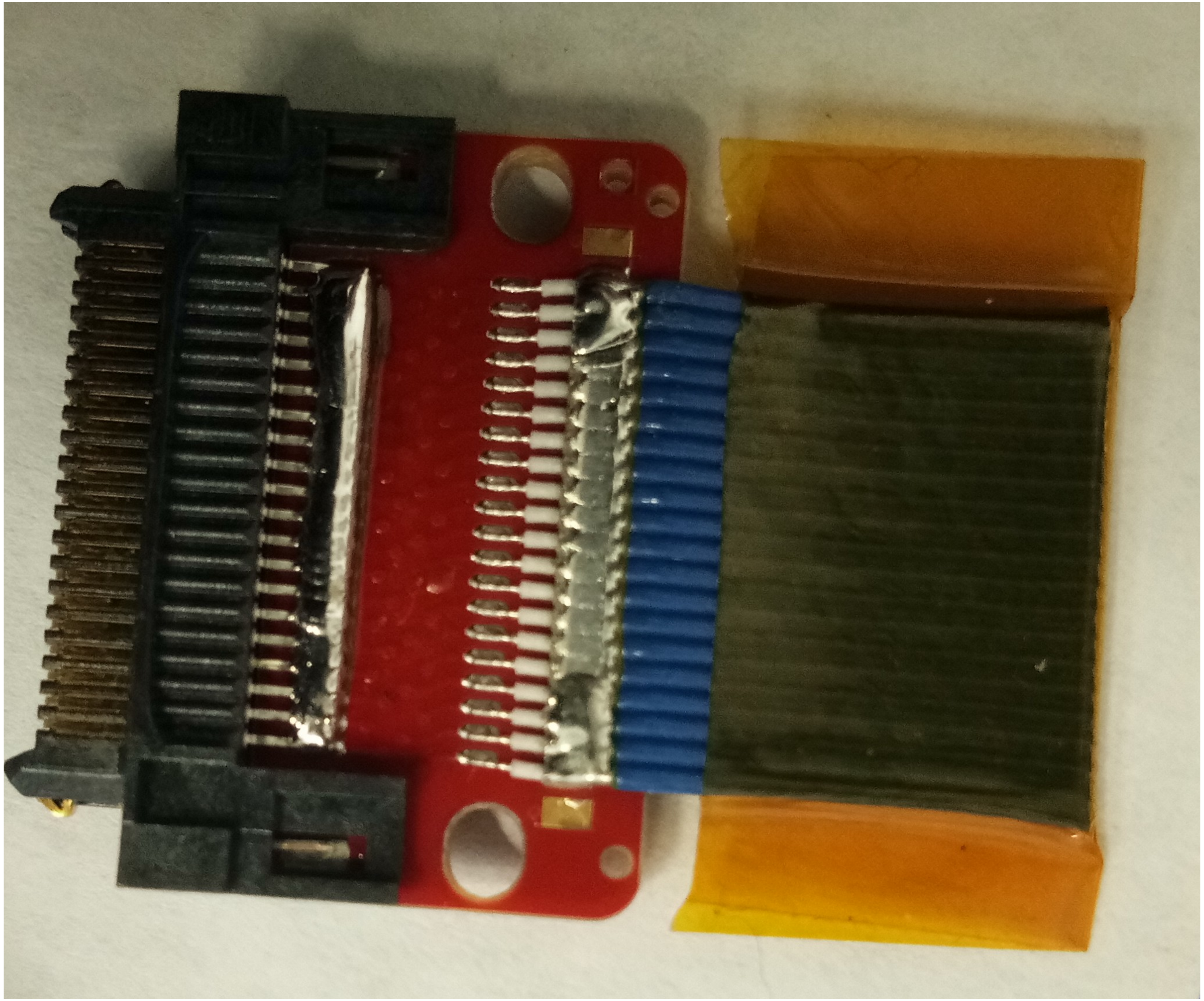
R25

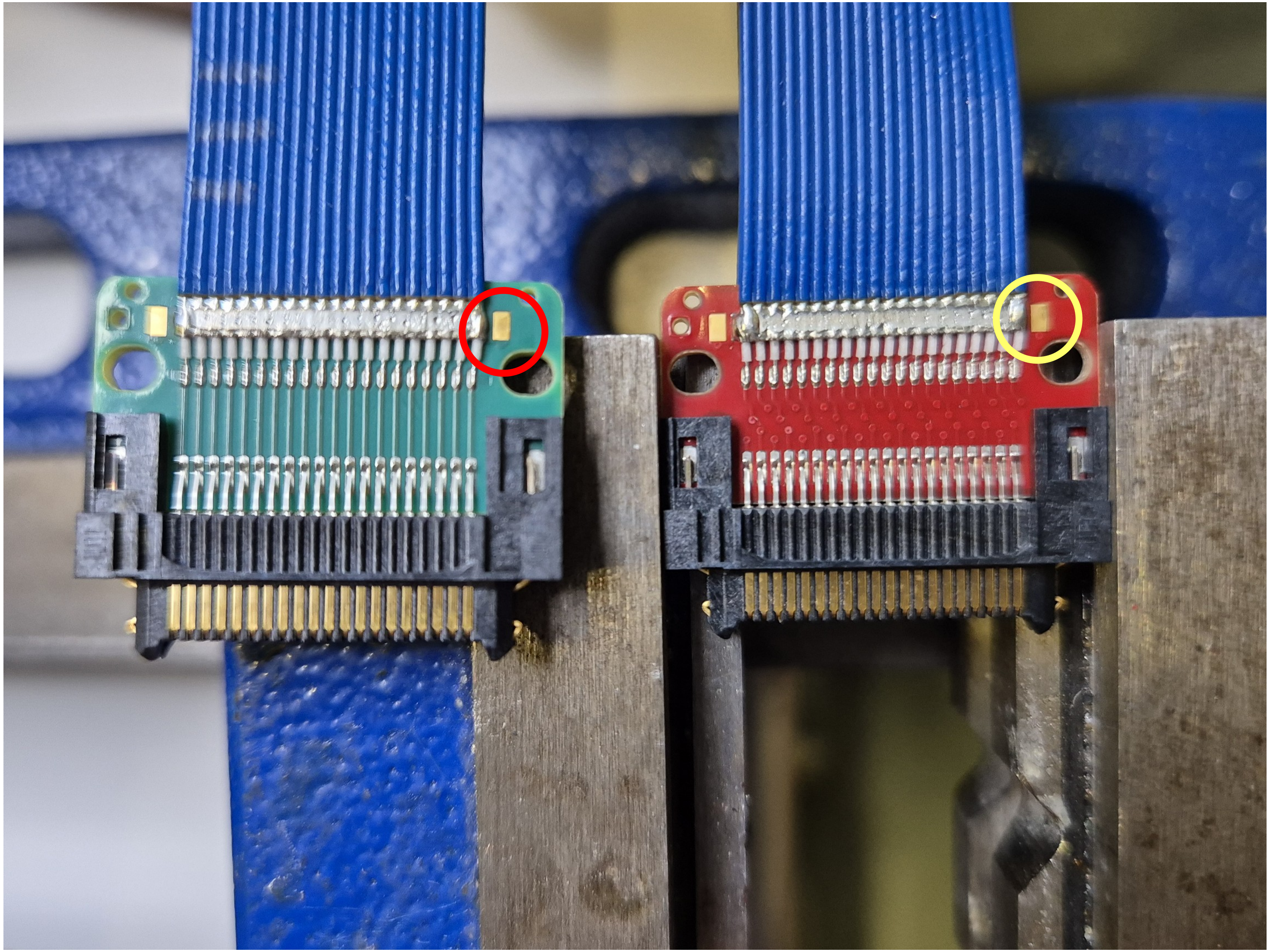
Leak measurement without G. caps

Leak from XoX to Anode @ 200 V: 160 nA
All leak going to the guard ring

Difference between grounded and floating Anode pads ~ 1 nA

Back ups

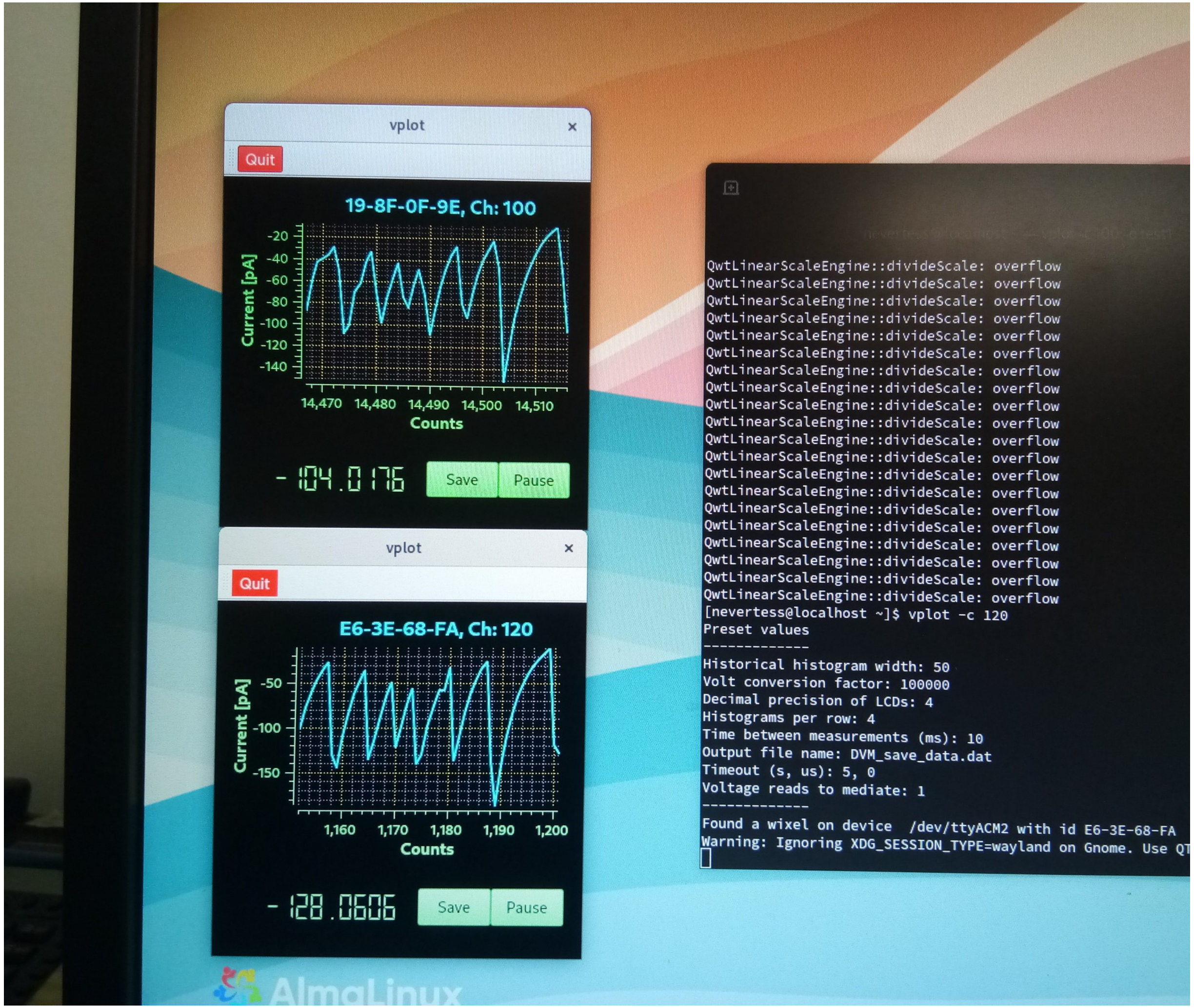




Different PCBs

- µ-coax cable-1 connected to pin 1 top vs. µ-coax cable-1 connected to pin 1 bottom

- Fluctuation at zero V
- Similar tend at two electrodes



Electrode layouts

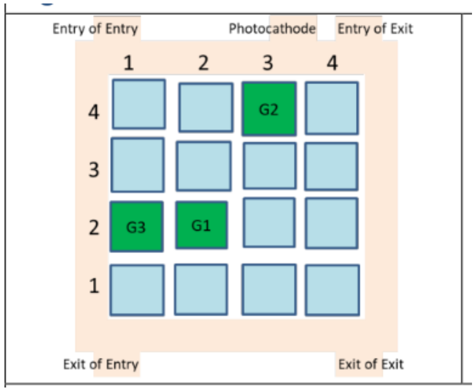
PC (Shifted towards left by 2 mm)

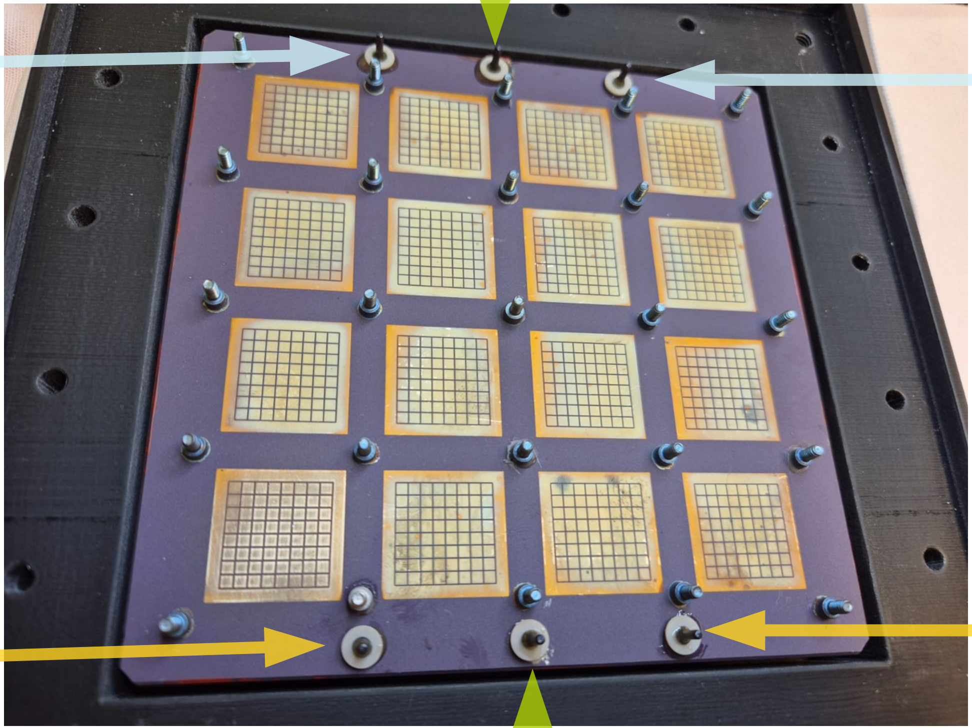
Entry MCP TOP

N_0N

Entry MCP BOTTOM

X_0N





Exit MCP TOP

N_0X

Exit MCP BOTTOM

X_0X

Ground

Few remarks to discuss:

1) R_MCP=7.3-8.7 MOhm - strange, LAPPD having 4 times larger area had R~4-5 MOhm... I would expect R~area... But I am wrong apparently.

2) leaks slides 7-8 - PC=0.25 GOhm/1.1 mm, MCPs=0.3 GOhm/1.2 mm, Anode=1.2 GOhm/2.5 mm - looks not linear with the distance, should it be linear? 2.3 GΩ/cm, 2.5 GΩ/cm, 4.8 GΩ/cm

3) absence of pad grounding:

I remember that LAPPD had leakage current of about 500-700 uA, lets assume HRPPD will have 200 uA, then

I_pad=200 uA * [3 mm/120 mm]^2 = 200 * 6.25e-4 = 0.125 uA

Few remarks to discuss：

voltage MCP2-Anode =200 V，capacitance C_pad=8.85 pF/m * (3 mm*120 mm)^2/(3+120 mm)/2.5 mm = 0.4 pF，therefore

dV=dQ/C=0.125 uA /0.4 pF = 0.3 V/s

thus，pad will be charging with rate 0.3 V/s and after 11 min. will cancel bias voltage of 200 V.

Adding a resistor to ground R will drain the charge to ground with characteristic time：

tau=R*C_pad=R* 0.4 pF=0.4 ns for R=1 kOhm

perhaps voltage variations of 2 V we can consider as negligible，it takes 2/0.3=6.7 s to build up this charge，therefore we need tau<<6.7 s ==> R<< 1000 GOhm.

In summary，charge build-up on the anode pads is slow，thus grounding resistor could be large.

> voltage MCP2-Anode =200 V, capacitance C_pad=8.85 pF/m * (3 mm*120
> mm)^2/(3+120 mm)/2.5 mm = 0.4 pF, therefore
> dV=dQ/C=0.125 uA /0.4 pF = 0.3 V/s
obviously I have lost orders of magnitude here uA/pF=MV ==> dV=0.3 MV
thus, pad will be charging with rate 0.3 MV/s and after 0.6 ms will
cancel bias voltage of 200 V.
voltage variations of 2 V we can consider as negligible, it takes
2/0.3e+6=6.7 us to build up this charge, therefore we need tau<<6.7 us
==> R<< 1 MOhm.

In summary, charge build-up on the anode pads is slow, thus grounding resistor MUST BE SMALL <<1 Mohm.

By the way, from the photos, it looks like it is possible to solder resistors on the connector - where coaxial cables are connected to the pins. Perhaps not all 32 channels, but some number of them.