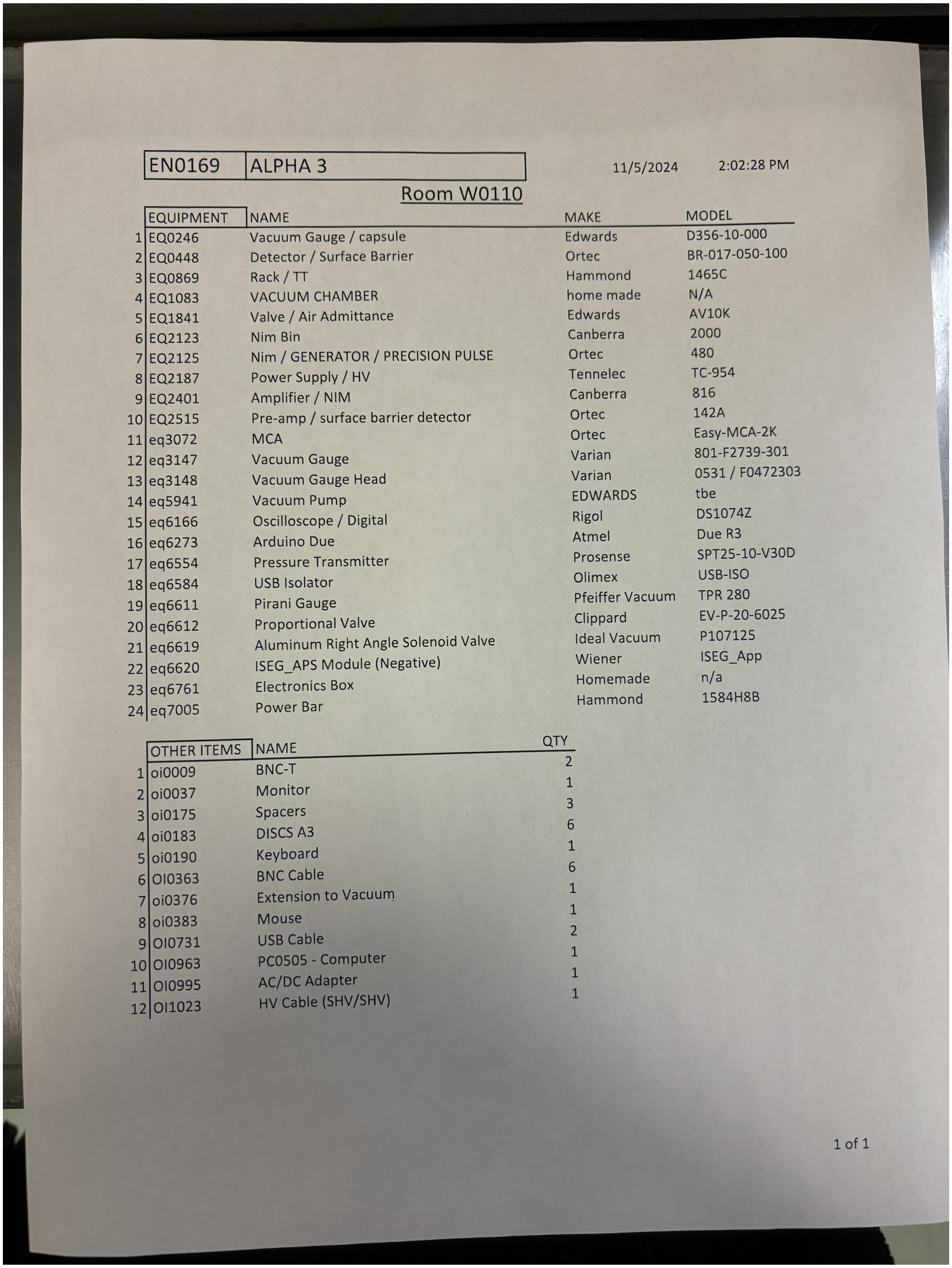
Lab 3: Alpha Decay

Tuesday nov 5



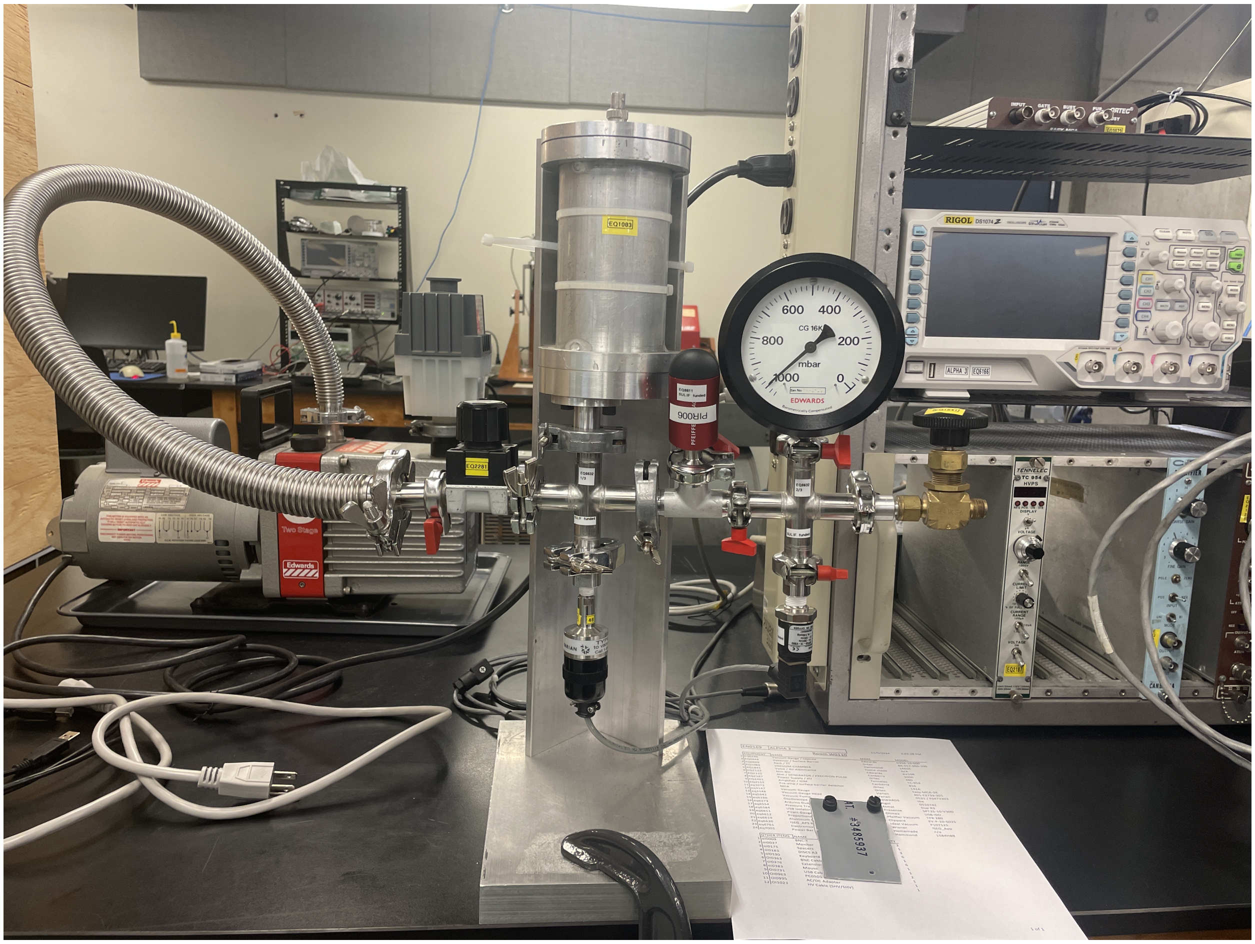
EN0169	ALPHA 3	11/5/2024	2:02:28 PM

Room W0110

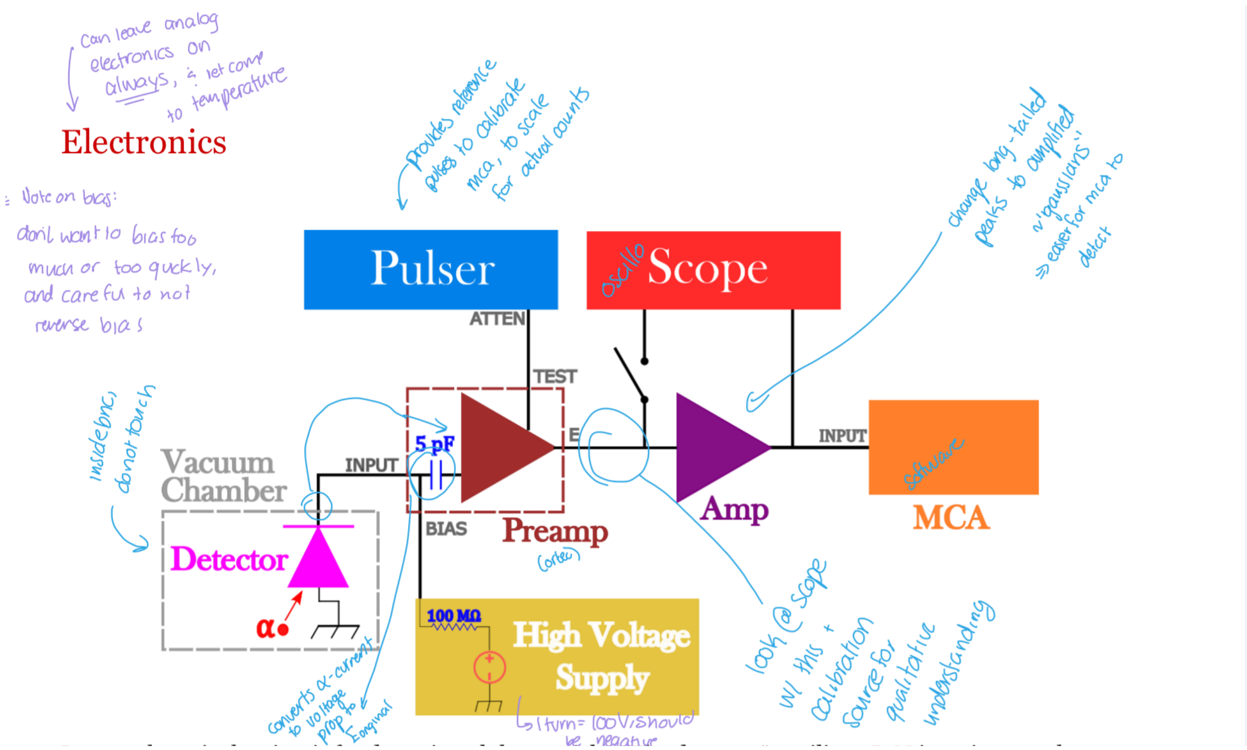
	EQUIPMENT	NAME	MAKE	MODEL
1	EQ0246	Vacuum Gauge / capsule	Edwards	D356-10-000
2	EQ0448	Detector / Surface Barrier	Ortec	BR-017-050-100
3	EQ0869	Rack / TT	Hammond	1465C
4	EQ1083	VACUUM CHAMBER	home made	N/A
5	EQ1841	Valve / Air Admittance	Edwards	AV10K
6	EQ2123	Nim Bin	Canberra	2000
7	EQ2125	Nim / GENERATOR / PRECISION PULSE	Ortec	480
8	EQ2187	Power Supply / HV	Tennelec	TC-954
9	EQ2401	Amplifier / NIM	Canberra	816
10	EQ2515	Pre-amp / surface barrier detector	Ortec	142A
11	eq3072	MCA	Ortec	Easy-MCA-2K
12	eq3147	Vacuum Gauge	Varian	801-F2739-301
13	eq3148	Vacuum Gauge Head	Varian	0531 / F0472303
14	eq5941	Vacuum Pump	EDWARDS	tbe
15	eq6166	Oscilloscope / Digital	Rigol	DS1074Z
16	eq6273	Arduino Due	Atmel	Due R3
17	eq6554	Pressure Transmitter	Prosense	SPT25-10-V30D
18	eq6584	USB Isolator	Olimex	USB-ISO
19	eq6611	Pirani Gauge	Pfeiffer Vacuum	TPR 280
20	eq6612	Proportional Valve	Clippard	EV-P-20-6025
21	eq6619	Aluminum Right Angle Solenoid Valve	Ideal Vacuum	P107125
22	eq6620	ISEG_APS Module (Negative)	Wiener	ISEG_App
23	eq6761	Electronics Box	Homemade	n/a
24	eq7005	Power Bar	Hammond	1584H8B

	OTHER ITEMS	NAME	QTY
1	oi0009	BNC-T	2
2	oi0037	Monitor	1
3	oi0175	Spacers	3
4	oi0183	DISCS A3	6
5	oi0190	Keyboard	1
6	OI0363	BNC Cable	6
7	oi0376	Extension to Vacuum	1
8	oi0383	Mouse	1
9	OI0731	USB Cable	2
10	OI0963	PC0505 - Computer	1
11	OI0995	AC/DC Adapter	1
12	OI1023	HV Cable (SHV/SHV)	1

1 of 1



Annotated diagram that we went through with Robert:



Understanding all the parts:

- Plugging the scope into the attenuated output of the pulse generator shows the sharp, long-tailed peaks that mimics the signals that will come from the source before going to the pre-amp
  - Need to have the attenuator on to have any pulse coming out
  - The pulses appear better when the trigger is on 'pulse'
  - Seeing consistent noise appearing consistently between the peaks

- The pre-amp
  - Putting the pulser into 'T' on the back of the preamp resulted in us just seeing noise
  - Putting it into the 'input' ont he preamp results in a square-shaped pulse
  - pre-amp is NOT shaping the pulse, it's converting it to a voltage

- We see a negative peak because the bias applied is negative
-

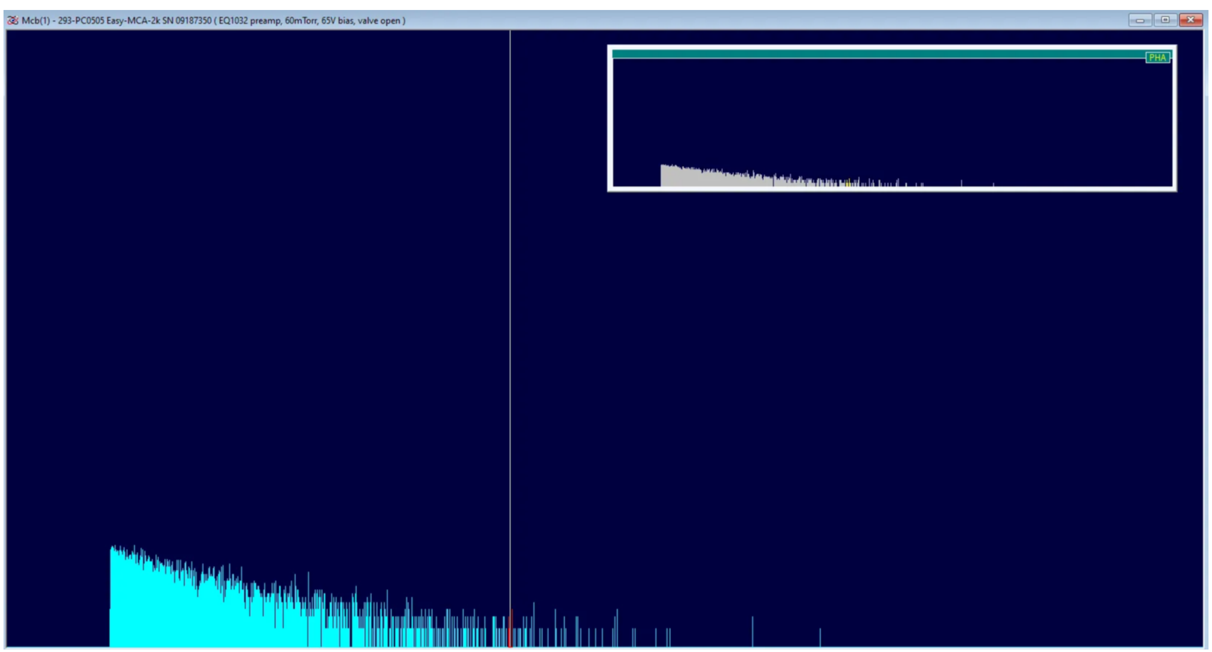
- Amplifier is re-shaping the pulse into something more gaussian
  - Amplifier set to B1
- MCA is getting the peak height and binning to get the result

Thursday Nov 7

Goal today: get the MCA connection working, and then try it with a cesium source

Connected to MCA:

From audrey banging the bnc on stuff



- pulser puts out at 60 Hz due to line voltage

Getting our pulse generator to work and register on the maestro:

- playing with the gain will help with removing the artefacts (likely from the capacitor charging and discharging in the pre-amplifier
- IMPORTANT: we need the peak coming out of the amplifier to be positive for the software to recognize it. This worked by setting the pulse generator to negative polarity and the input of the amplifier to positive
- the amplifier needs to be in unimodal mode, otherwise it will output a positive and negative peak
- the pole-zero knob can be adjusted using a screwdriver, but it seems to be fine at the lowest setting so far

tuesday nov 12

Fixing the signs

- the sign coming out of the input (from the samples) is negative, we need to set the input on the amplifier to negative to it anticipates a negative input.
- The pulser needs to be set to positive to match the signs.
- Question: why is the signal out of the source negative??

Goal today:

- open the data files on python and see if we can start getting calibration data
- try and get more calibration data

For the calibration, we have 2 americium peaks (which we believe to be at 5.486 and 5.443MeV, as these are the most common decays for Am). We also have out pulser peak, which Brandon told us is set to output at 60Hz. We can convert this to energy. We want to try converting this into energy to get a third calibration point.

Nevermind!!

Our pulser is at -740mV, and the output of the amplifier is at 8.8V. When we turn the pulser off, we see a smaller peak on the oscilloscope from the Am sample (-260mV input, 2.4V output from the amplifier).

alpha bin 468 marker

pulser bin 1709 marker

So we have one point from the americium, and another from the pulser. We can tune the pulser until it is at the same marker as the americium, and then double the voltage of the pulser to build a scale.

So we have 2.4 V → 5.468 MeV at marker 468

Moving the pulser to 4.80V (-440mV)→ gives position on 10.936 MeV, at marker 939

Thursday November 14

goal today: get the lead in

turning the system back on, the pulser is at the same position, which is good

We'll still get the americium source to do the calibration again today for ~30min, and then spend the rest of the day with the lead in varying the pulser to get more calibration:

min (pulse) mV	max (amplifier) V	bin #
-430	4.7	939
-720	8.7	1709
-260	2.4	474
-160	1.1	218
-306	3.0	593
-370	4.0	787
-520	6.0	1169
-600	7.1	1384

Uncertainty: oscilloscope switches, max 0.2V, and min 10mV

charging disk 1 for 22min, seeing some peaks roughly around the expected energies based on a rough calibration.

Pressure around 80 millitorr

Ideas for interim report:

- do our calibration to get our final bin to energy conversions
- show the results from our americium source and rough detection for lead
- do some calculations for us leaving the source charging for four days

12:21 pm on friday we put it in

sample removed at 12:58pm on tuesday

Thursday nov 21

- pressure dependence: get counts at different pressures, use bethe formula to get stopping power of air
- half lives + branching fractions: compare number of counts

plan:

do long runs this week and start the analysis for the half life stuff this weekend; check our results with dave. next week, do the shorter pressure runs

Tuesday Nov 26

Playing with pressure

We left the same sample that's been in the chamber for over a week in the charging station from 10:35 am to 2:07pm

We plan on doing 20 minute counts at varying pressures to get the dependence with air today.

We'll also use spacers to place the sample closer to the detector

Starting with pressure = 200mB, and we'll run each for 20 minutes

Next run: 100mB

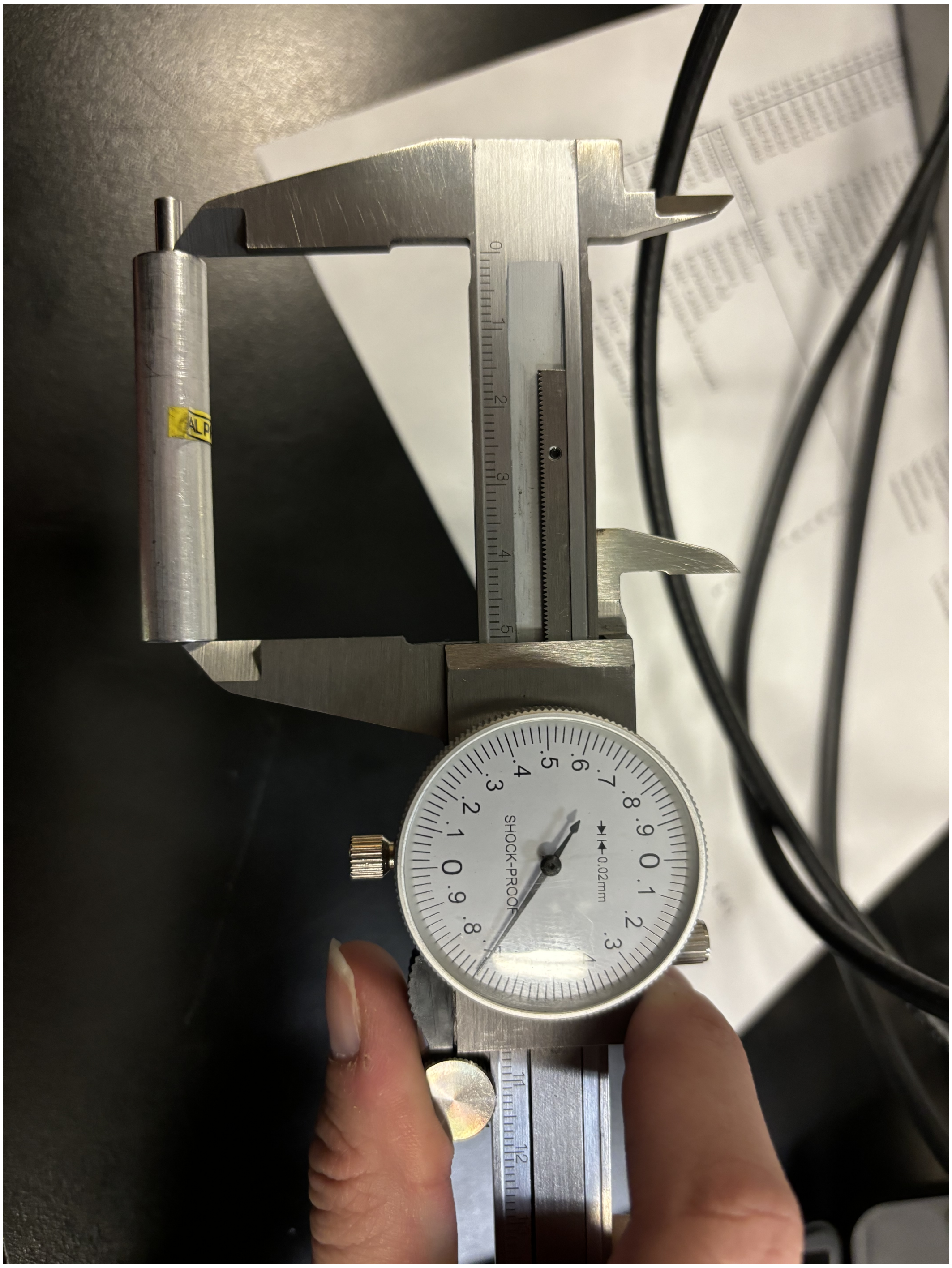
Thursday November 28

redoing calibration

We’re using sillyscope to take more precise voltage readings for the pulser calibration, so we can re-construct our channel-voltage deendence with better uncertainties.

dimensions:

- spacer: 50.7 +-0.02mm



Plan for the pressure dependence

For a single peak of lead, we want to look at the pressure dependence of the energy using the bethe formula

We can calculate -dE/dx at every pressure for a peak. dx is the length travelled through the gas (see above), dE is the difference in energy from a reference energy/pressure (can pick the lowest one). We expect that -dE/dx will be proportional to pressure ie linear fit.

dx is constant in our case, so we want to look at how much the energy is changing with the pressure

We can compare this to the theoretical values calculated using the bethe formula? (or just use theoretical values from the manuals)

We can plot this for all the peaks of lead

Plan for half-life calculations:

from our long lead run, we observe 4 peaks around one energy and one peak at another energy, which reflects the four possible energy level decays into Tl208 and the 1 possible into Po212. We can get the relative abundances for the 4 energy levels of Tl.

For the half-life calculations, we know the number that decayed and over what time period. If we assume the source is in equilibrium such that production = decay, and that the count rate remained constant throughout the run, then the following should be valid.

Average count rate is Ravg = Ntotal / Ttotal

Then Ravg = N*lambda, and T1/2 = ln(2)/lambda, so that should give the half life.