Radiation Protection and the Safety of the Radiation Sources

INTEREST-INTERNATIONAL **RE**MOTE **S**TUDENT **T**RAINING AT JINR
WAVE 6

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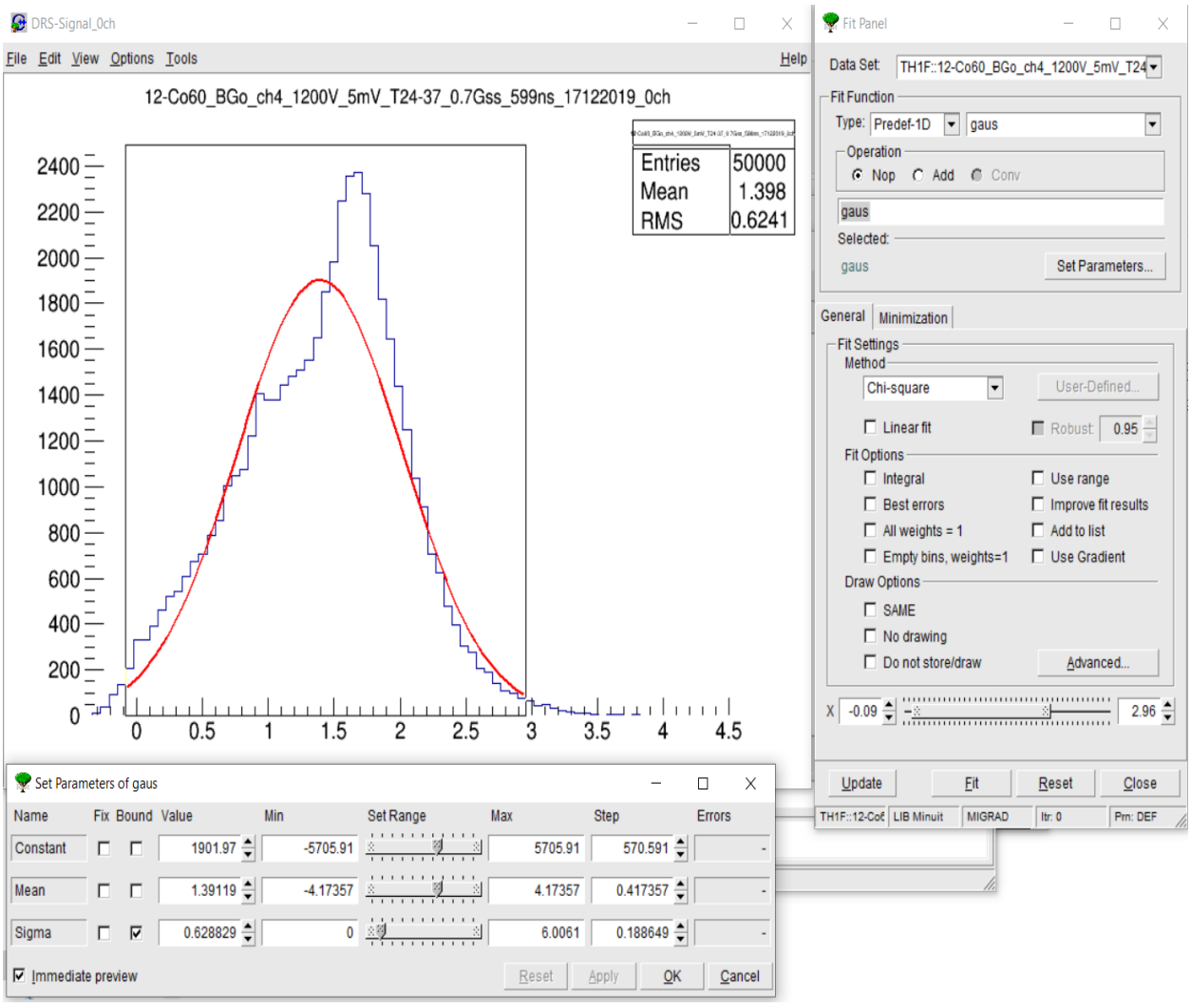
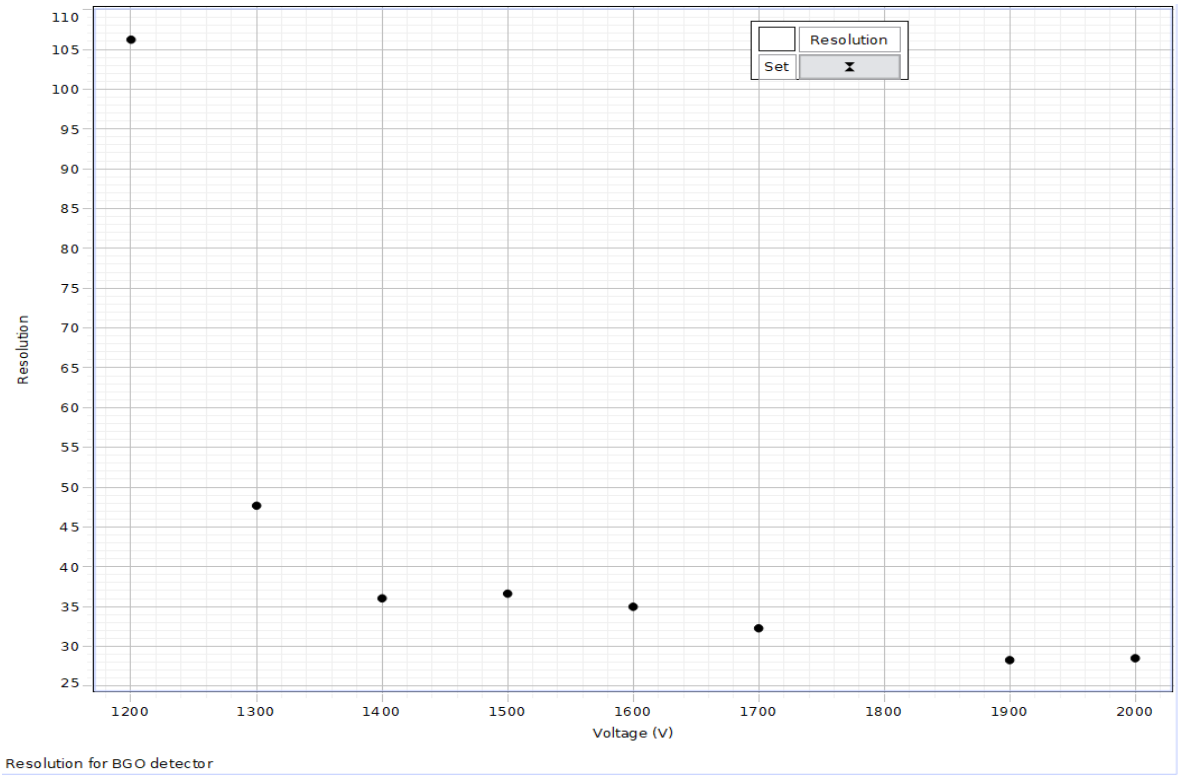
TASK 1: RESOLUTION FOR BGO DETECTOR

$$R = \frac{Sigma}{Mean} * 2.35 * 100$$

- ✓ The Sigma & Mean are statistical parameters, so we should fit our data to get them.
- ✓ We follow the previous equation to get the Resolution.
- ✓ We plot the Resolution on Y-axis and the applied voltage on X-axis.



Voltage (V)	Mean	sigma	Resolution
1200	1.39119	0.628829	106.2219
1300	1.38702	0.281575	47.7067
1400	1.92403	0.294769	36.0029
1500	2.98400	0.465246	36.6397
1600	4.40174	0.655654	35.0040
1700	6.08761	0.836223	32.2807
1900	10.65120	1.281030	28.2637
2000	13.57300	1.646460	28.5065



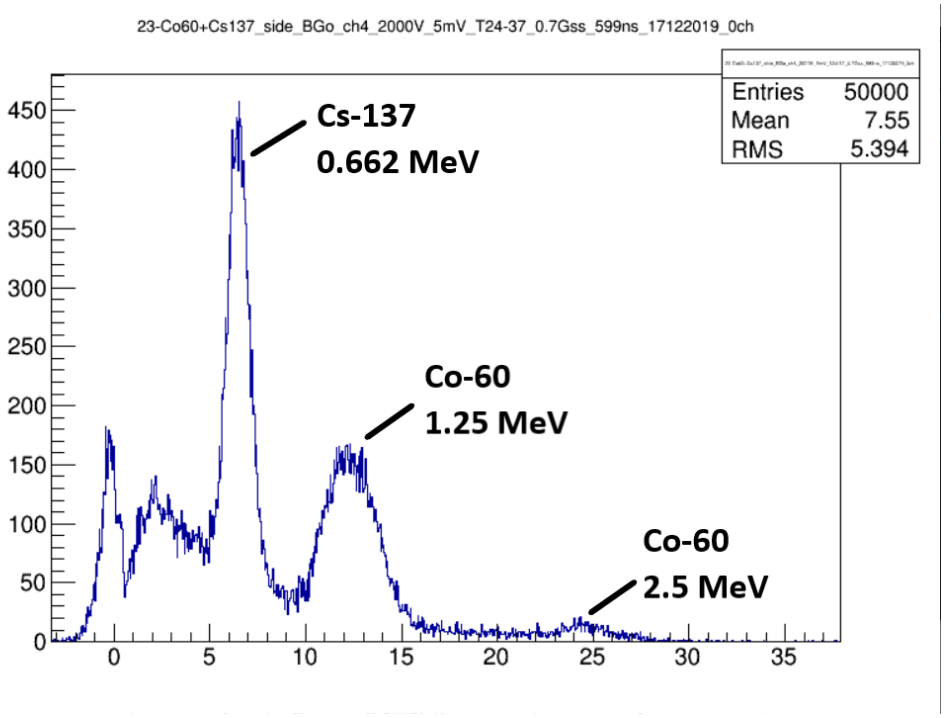
Resolution for BGO detector

As we see, the more the applied voltage, the more the resolution. But should optimize the applied voltage in which we get the highest resolution without breaking the calibration.

At 1300 V → R = 47.7%

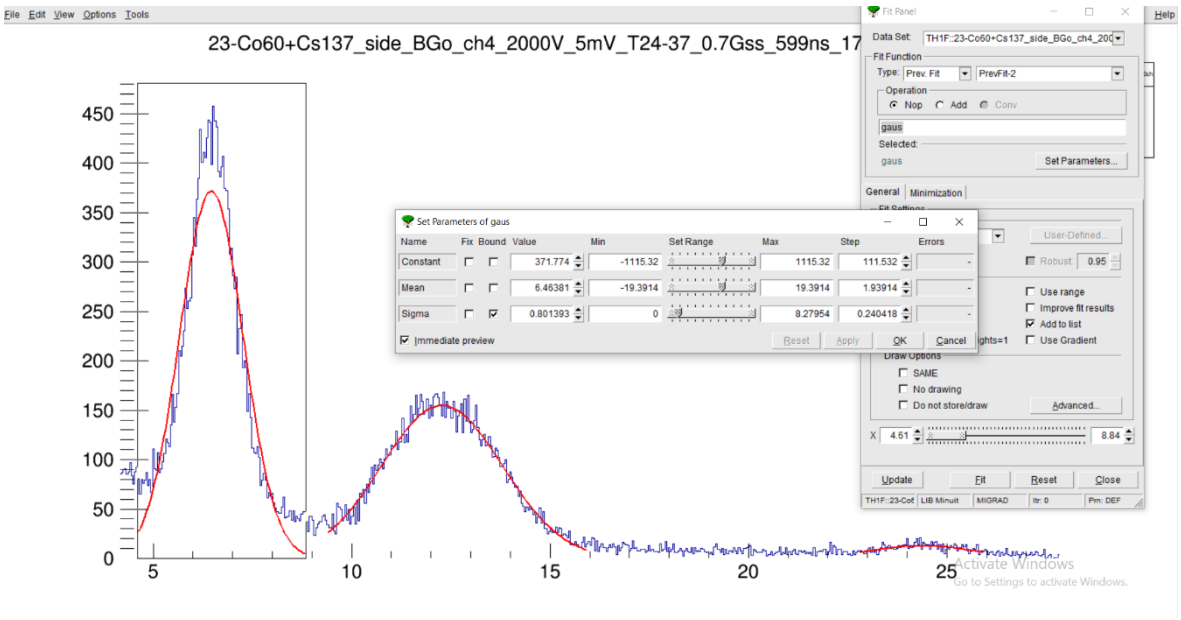
At 2000 V → R = 28.5 %

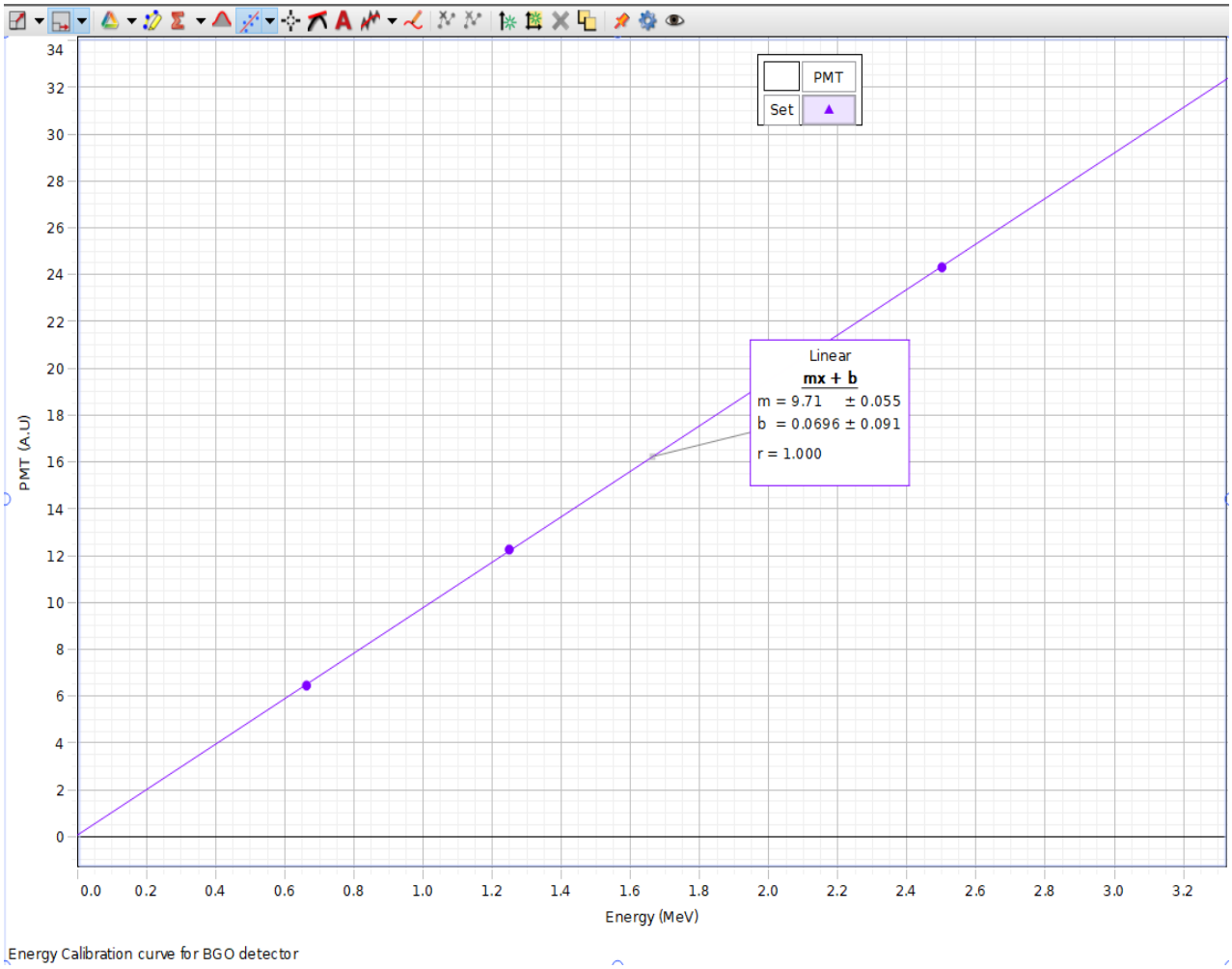
TASK 2.1: ENERGY CALIBRATION FOR BGO DETECTOR



- ✓ Again, we need the Mean values for these three peaks
- ✓ We plot a graph between the Mean on Y-axis and the Energy on the x-axis

Energy (MeV)	PMT (A.U)
0.662	6.45607
1.250	12.26220
2.500	24.31920





Energy Calibration curve for BGO detector

TASK 2.2: DETERMINING ENERGY OF UNKNOWN SOURCE

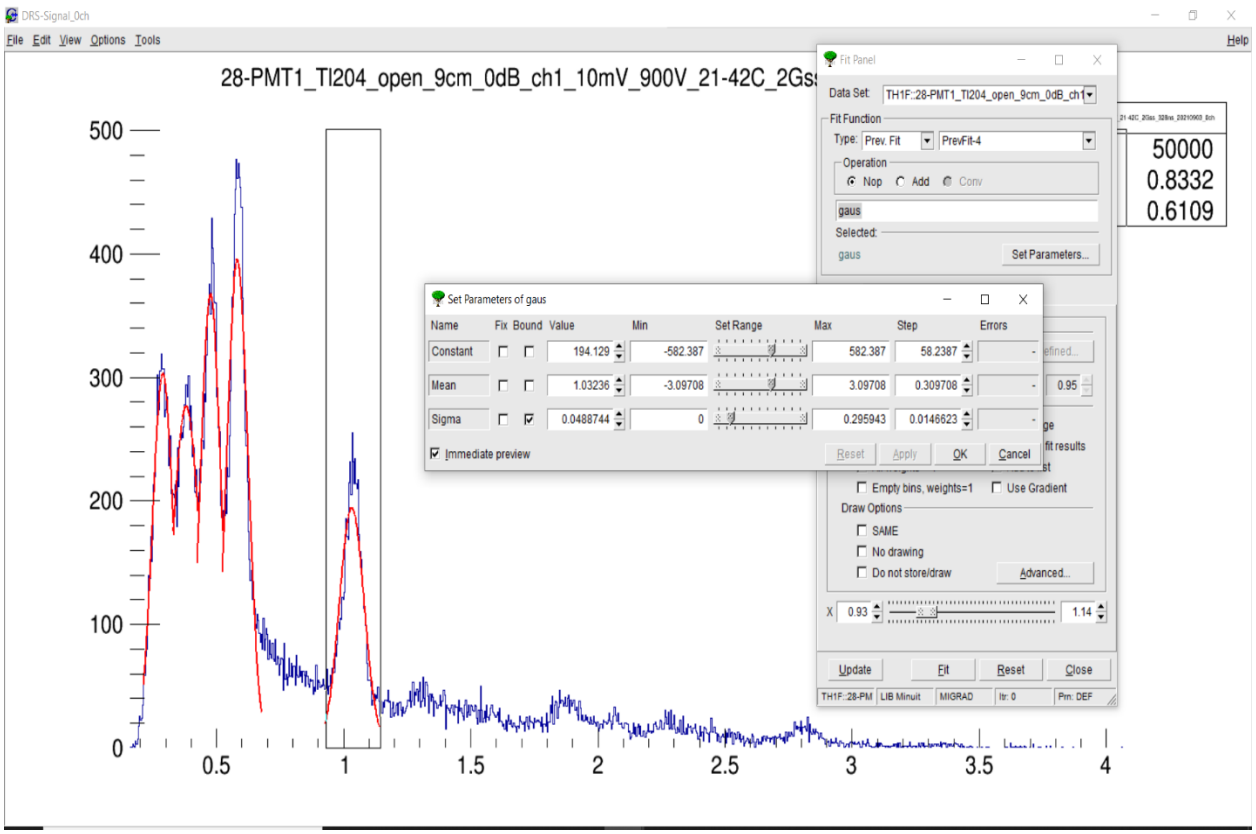
The equation of the straight line in the previous graph is

$y = 9.71\,x + 0.0696$

- ✓ The x indicates the energy
- ✓ The y indicates the PMT signal (Mean)

So, we can determine the energy of an unknown source using this equation by knowing the Mean value only

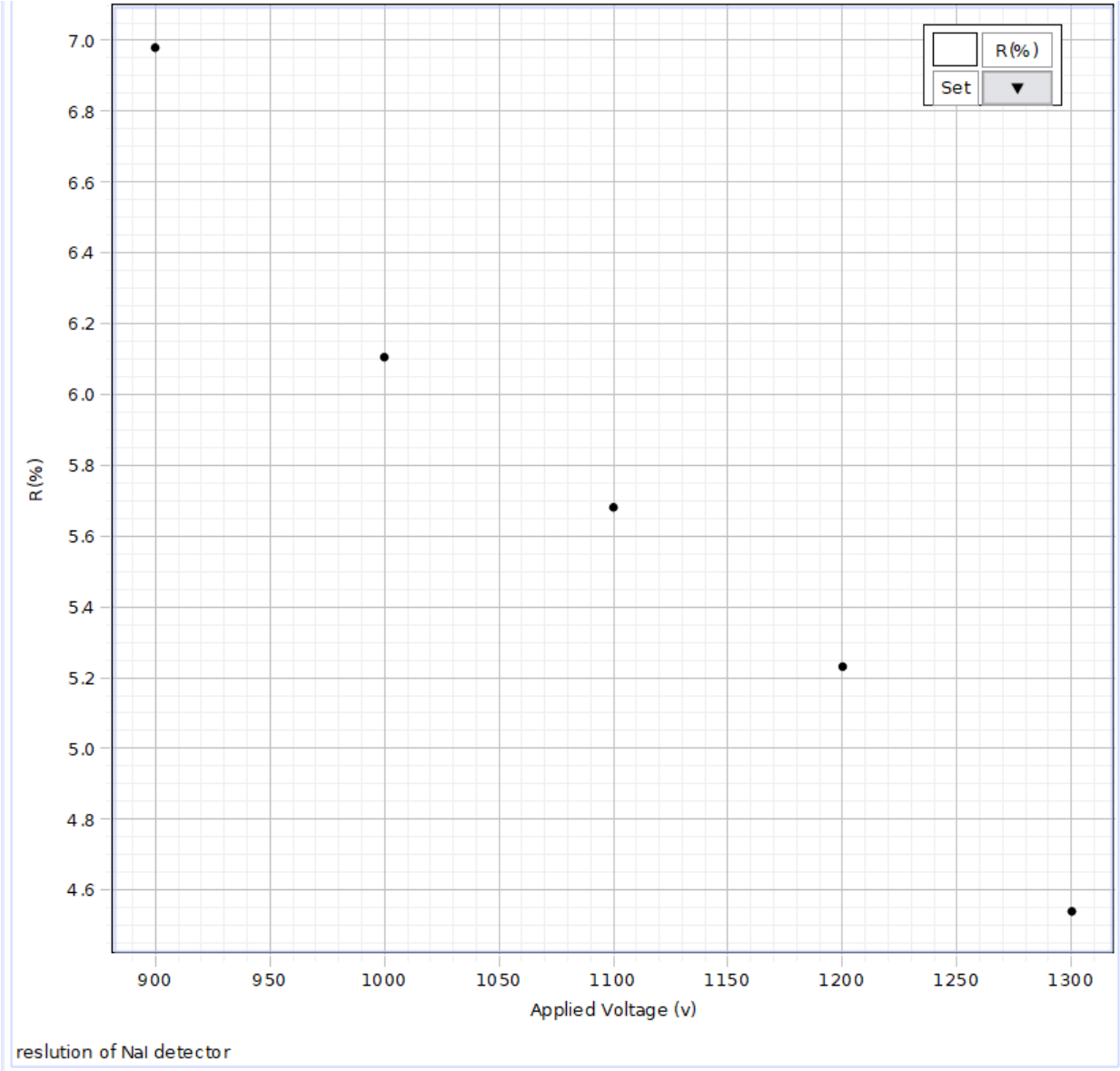
$$\text{Energy} = \frac{(\text{Mean} - 0.0696)}{9.71}$$



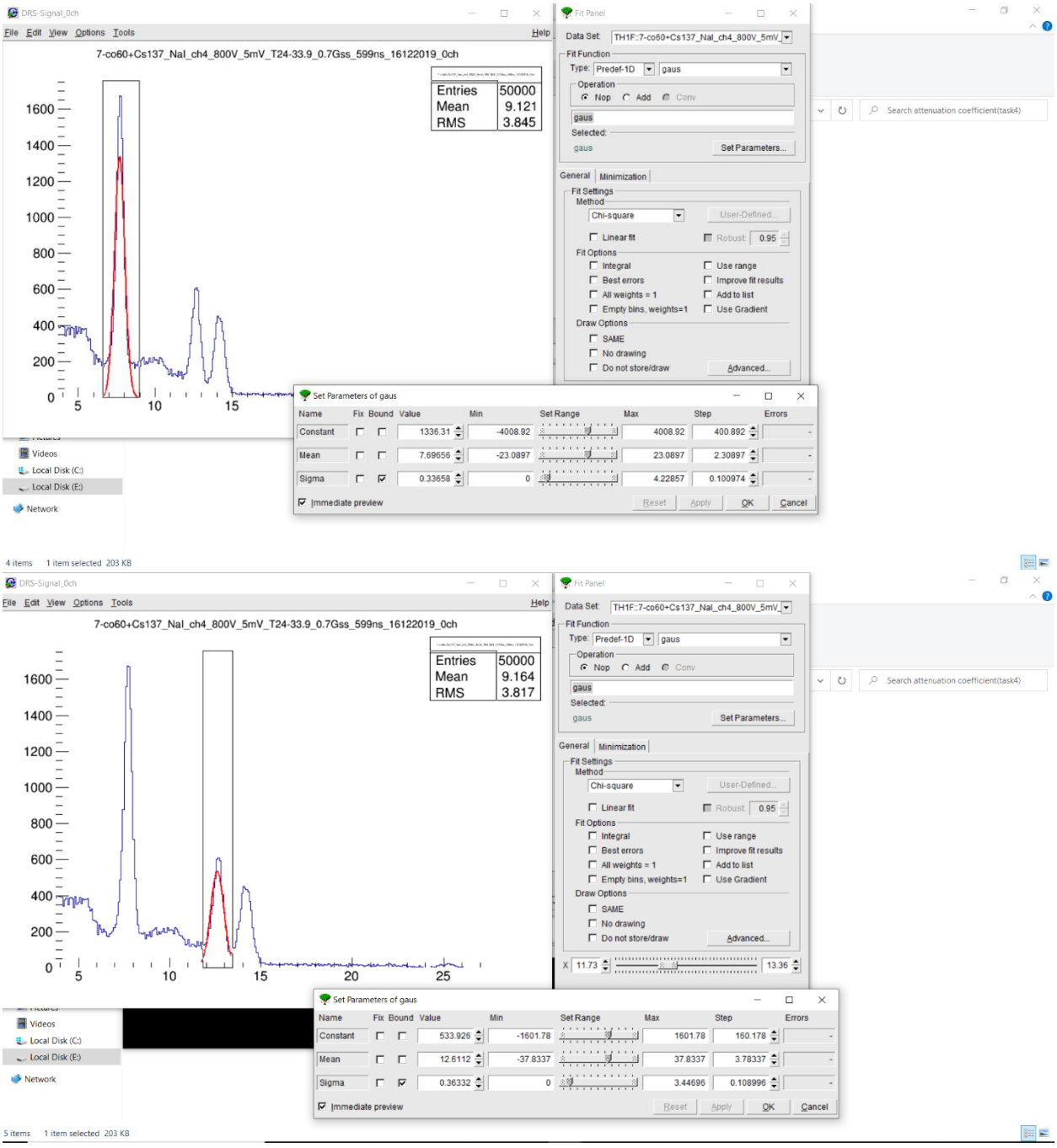
Mean	Energy (MeV)	Energy2 (KeV)	unknown source
0.28968	0.02254	22.54	Sm-151
0.38146	0.03194	31.94	Mg-28
0.47737	0.04176	41.76	I-129 or Rh-103m
0.58249	0.05252	52.52	Rh-104m
1.03236	0.09859	98.59	Dy-165

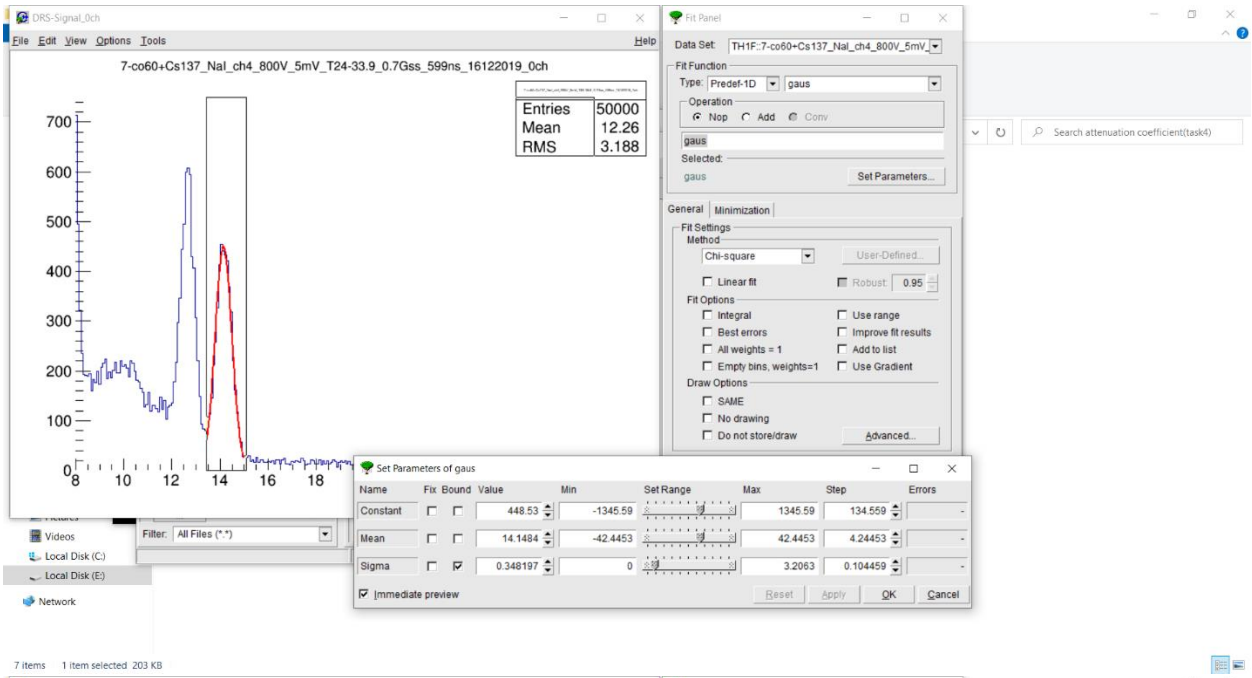
TASK 3: RESOLUTION FOR NaI DETECTOR

Applied Voltage (v)	Mean	sigma	Resolution	R(%)
900	23.6267	0.701646	0.0698	6.98
1000	40.5992	1.054550	0.0610	6.10
1100	65.7567	1.589430	0.0568	5.68
1200	98.6401	2.195640	0.0523	5.23
1300	137.3660	2.653980	0.0454	4.54



TASK 4.1: ENERGY CALIBRATION FOR NaI DETECTOR




DRS-Signal_0ch
File Edit View Options Tools Help
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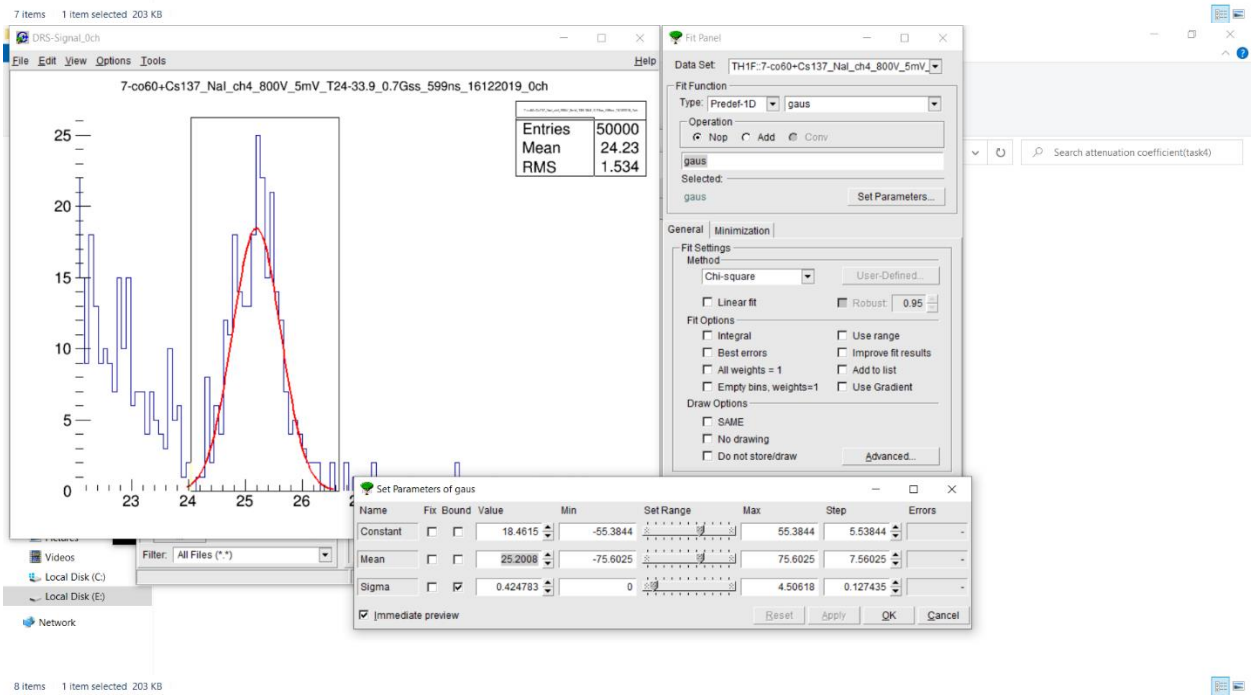
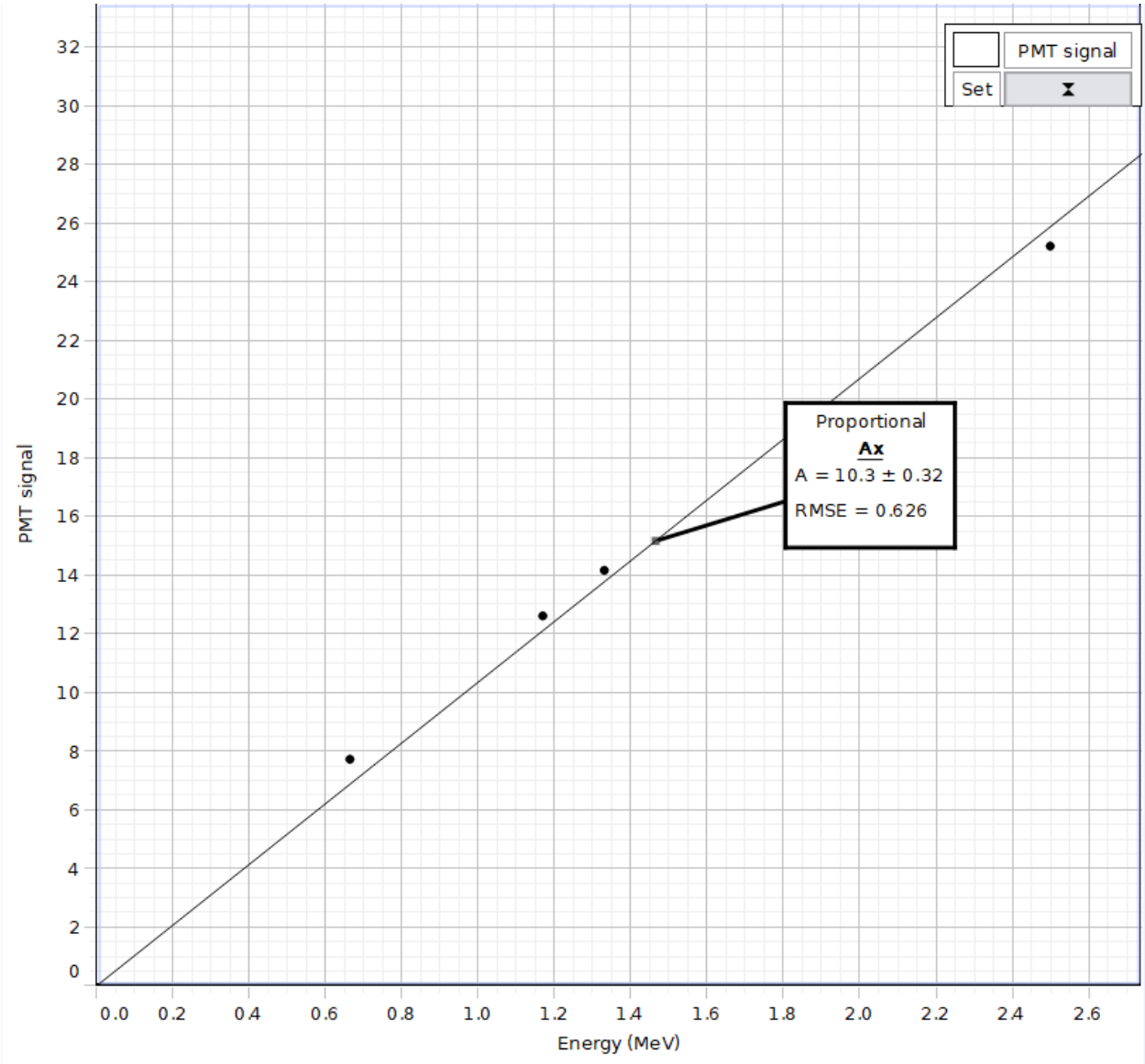
Entries 50000
Mean 12.26
RMS 3.188
Fit Panel
Data Set: TH1F::7-co60+Cs137_NaI_ch4_800V_5mV
Fit Function
Type: Predef-1D gaus
Operation
Nop Add Conv
gaus
Selected:
gaus
Set Parameters...
General Minimization
Fit Settings
Method
Chi-square
User-Defined...
Linear fit
Robust: 0.95
Fit Options
Integral
Use range
Best errors
Improve fit results
All weights = 1
Add to list
Empty bins, weights=1
Use Gradient
Draw Options
SAME
No drawing
Do not store/draw
Advanced...
Set Parameters of gaus
Name Fix Bound Value Min Set Range Max Step Errors
Constant 448.53 -1345.59 1345.59 134.559
Mean 14.1484 -42.4453 42.4453 4.24453
Sigma 0.348197 0 3.2063 0.104459
Immediate preview
Reset Apply OK Cancel
Search attenuation coefficient(task4)
Videos
Local Disk (C:)
Local Disk (E:)
Network
Filter: All Files (*.*)
7 items 1 item selected 203 KB

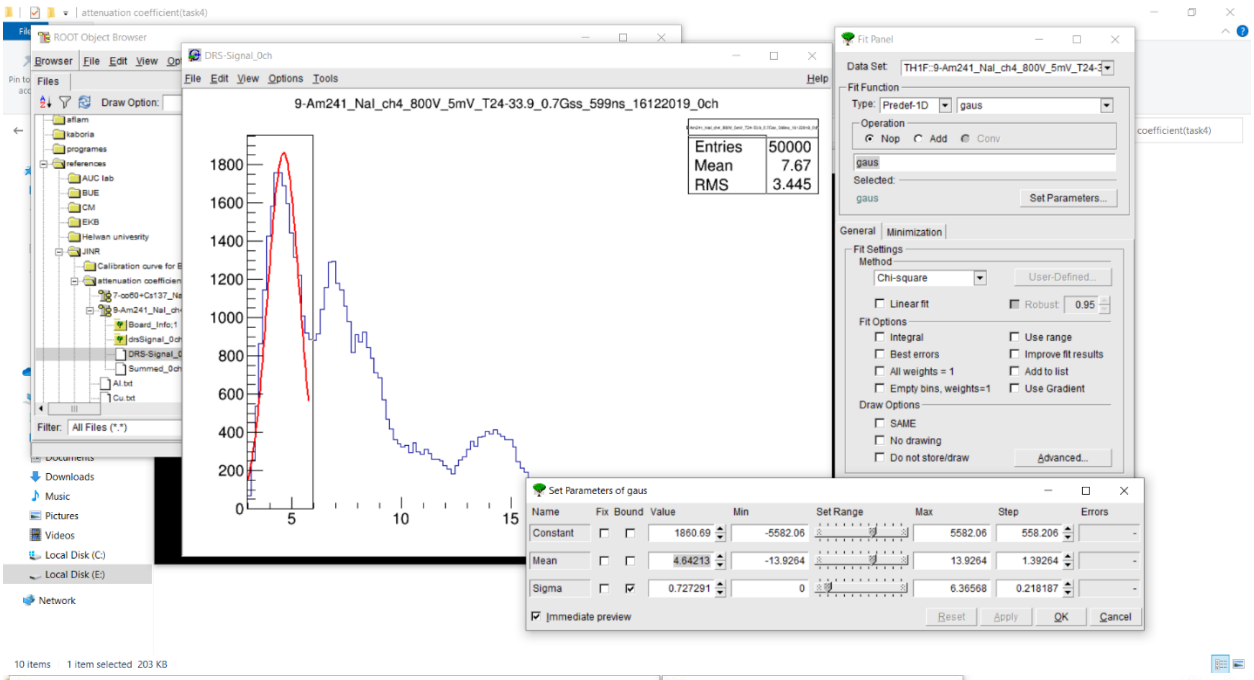

DRS-Signal_0ch
File Edit View Options Tools Help
7-co60+Cs137_NaI_ch4_800V_5mV_T24-33.9_0.7Gss_599ns_16122019_0ch
Entries 50000
Mean 24.23
RMS 1.534
Fit Panel
Data Set: TH1F::7-co60+Cs137_NaI_ch4_800V_5mV
Fit Function
Type: Predef-1D gaus
Operation
Nop Add Conv
gaus
Selected:
gaus
Set Parameters...
General Minimization
Fit Settings
Method
Chi-square
User-Defined...
Linear fit
Robust: 0.95
Fit Options
Integral
Use range
Best errors
Improve fit results
All weights = 1
Add to list
Empty bins, weights=1
Use Gradient
Draw Options
SAME
No drawing
Do not store/draw
Advanced...
Set Parameters of gaus
Name Fix Bound Value Min Set Range Max Step Errors
Constant 18.4615 -55.3844 55.3844 5.53844
Mean 25.2008 -75.6025 75.6025 7.56025
Sigma 0.424783 0 4.50618 0.127435
Immediate preview
Reset Apply OK Cancel
Search attenuation coefficient(task4)
Videos
Local Disk (C:)
Local Disk (E:)
Network
Filter: All Files (*.*)
8 items 1 item selected 203 KB

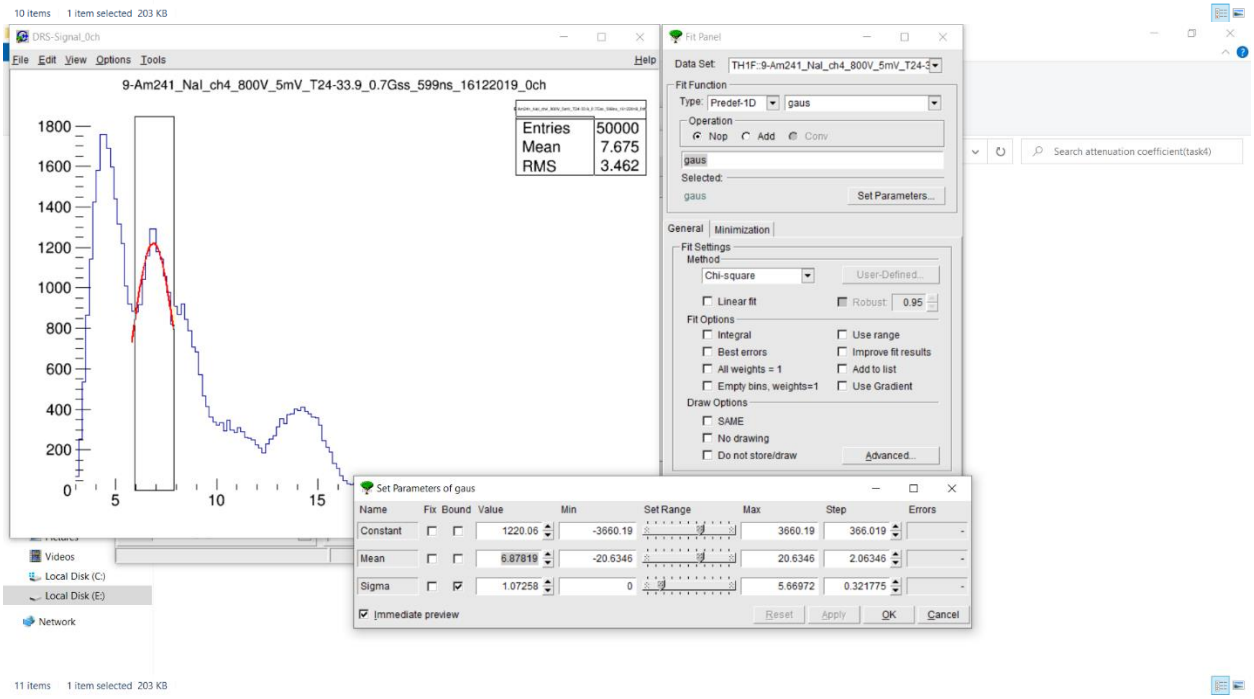
Source	Energy (MeV)	PMT signal
Cs-137	0.662	7.69656
Co-60	1.170	12.61120
Co-60	1.330	14.14840
Co-60	2.500	25.20080

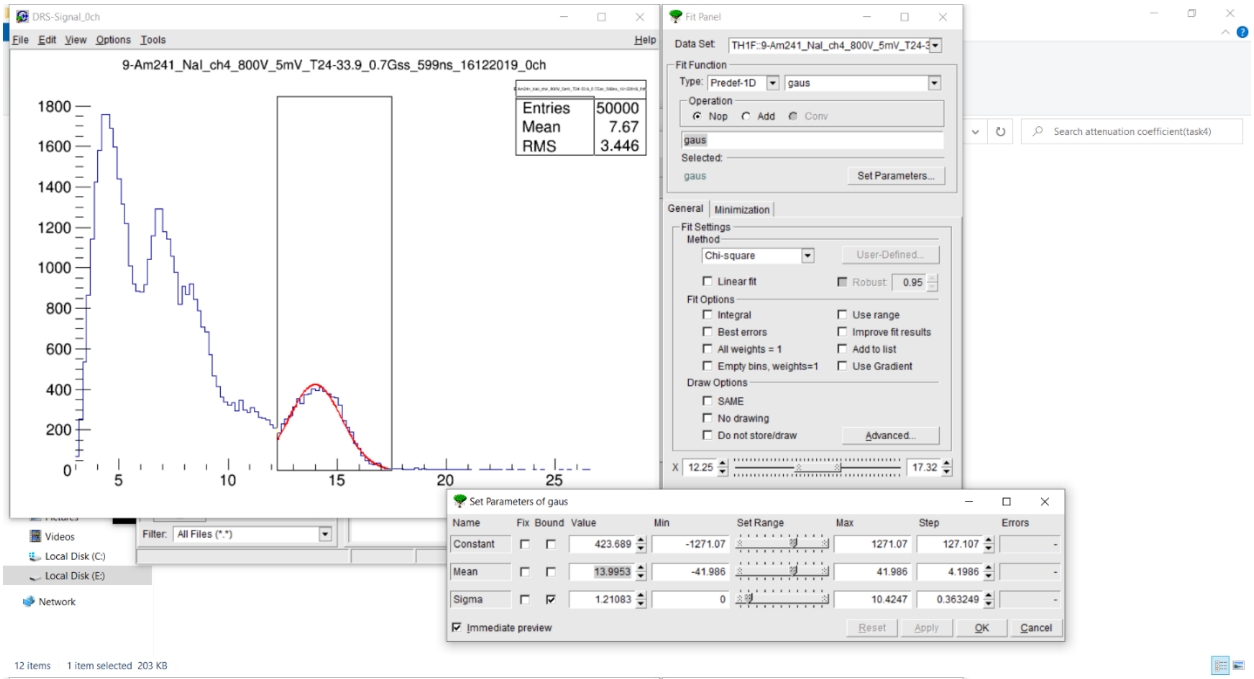


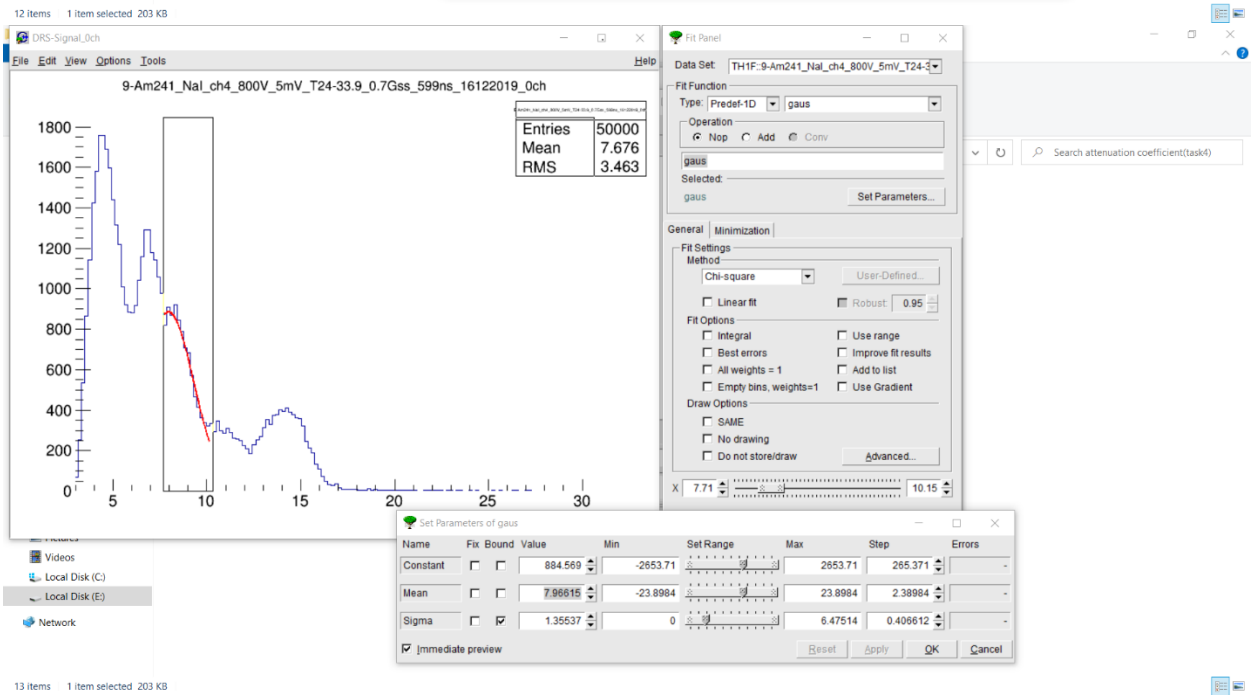
Calibration curve for NaI detector

TASK 4.2: DETERMINING ENERGY OF UNKNOWN SOURCE BY NaI DETECTOR





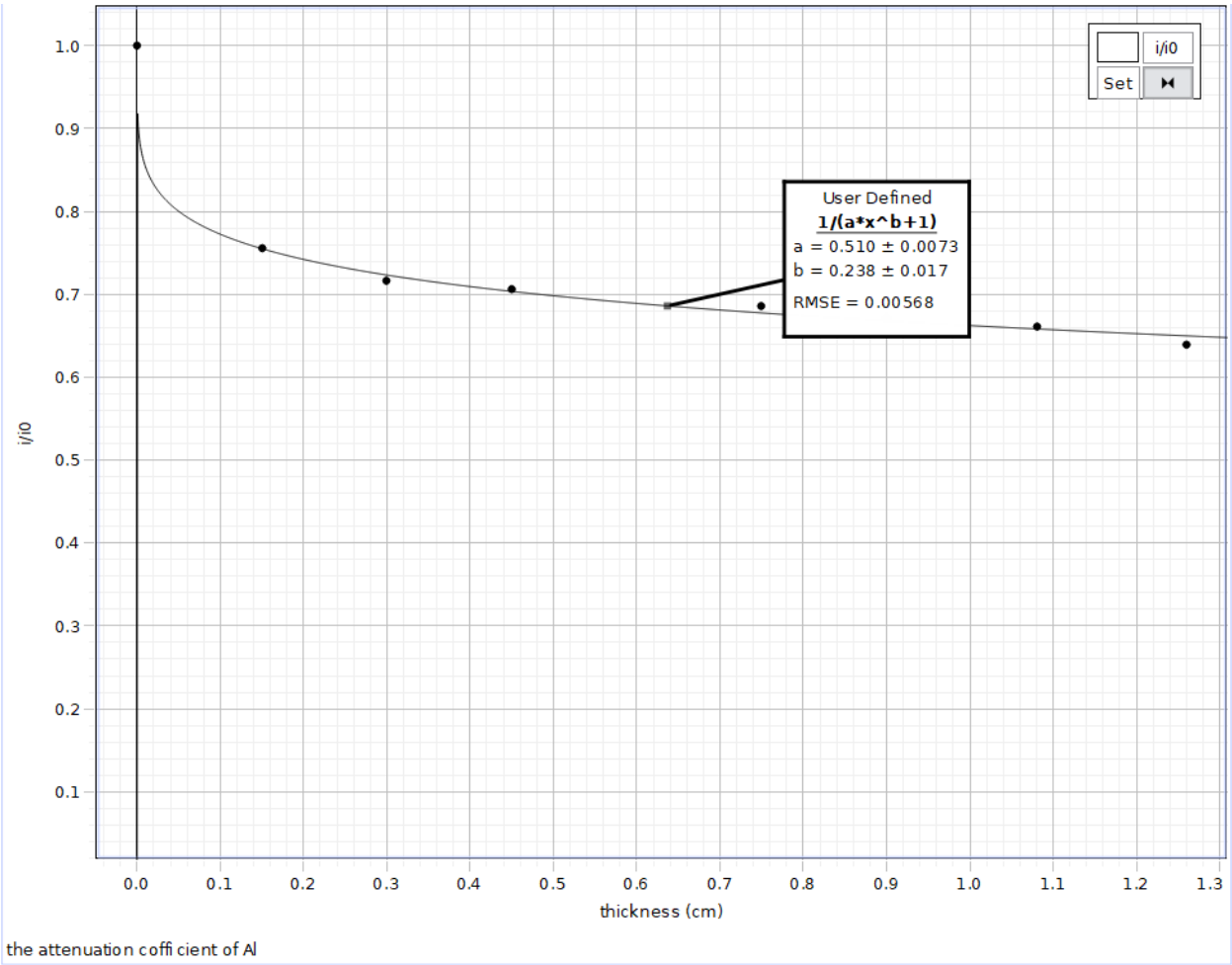




Mean	E (MeV)	E' (KeV)	unknown source
4.64213	0.45	450.69	Hf-180m
6.87819	0.67	667.79	Cs-137 / Ba-137m
7.96615	0.77	773.41	I-132
13.99530	1.36	1358.77	Mg-28

TASK 4.3: DETERMINING ATTENUATION COEFFICIENT OF Al

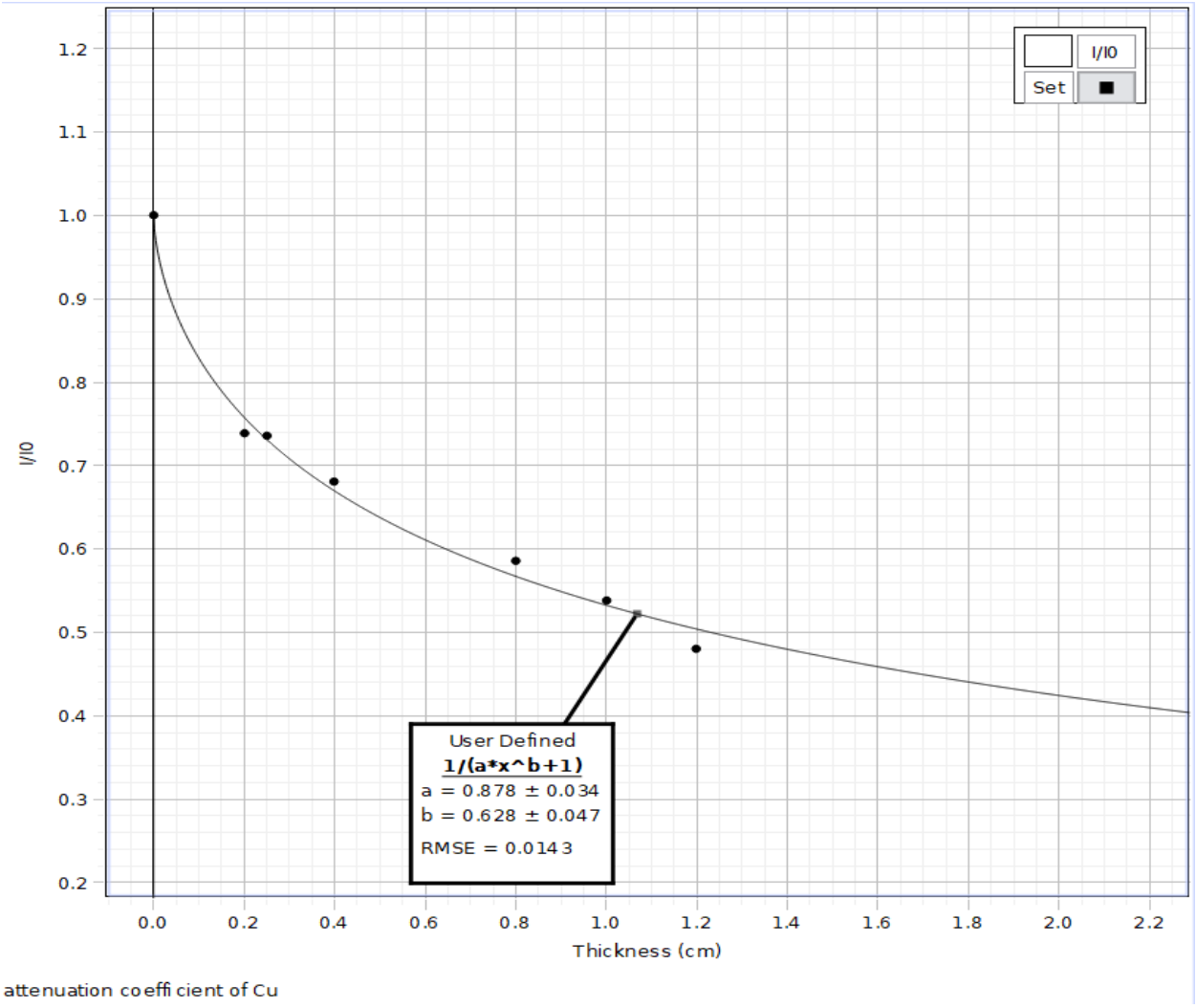
thickness (cm)	i/i0
0.00	1.00000
0.15	0.75573
0.30	0.71623
0.45	0.70569
0.75	0.68596
0.90	0.67155
1.08	0.66103
1.26	0.63939



The attenuation coefficient of Al is parameter b which is 0.238

TASK 4.4: DETERMINING ATTENUATION COEFFICIENT OF Cu

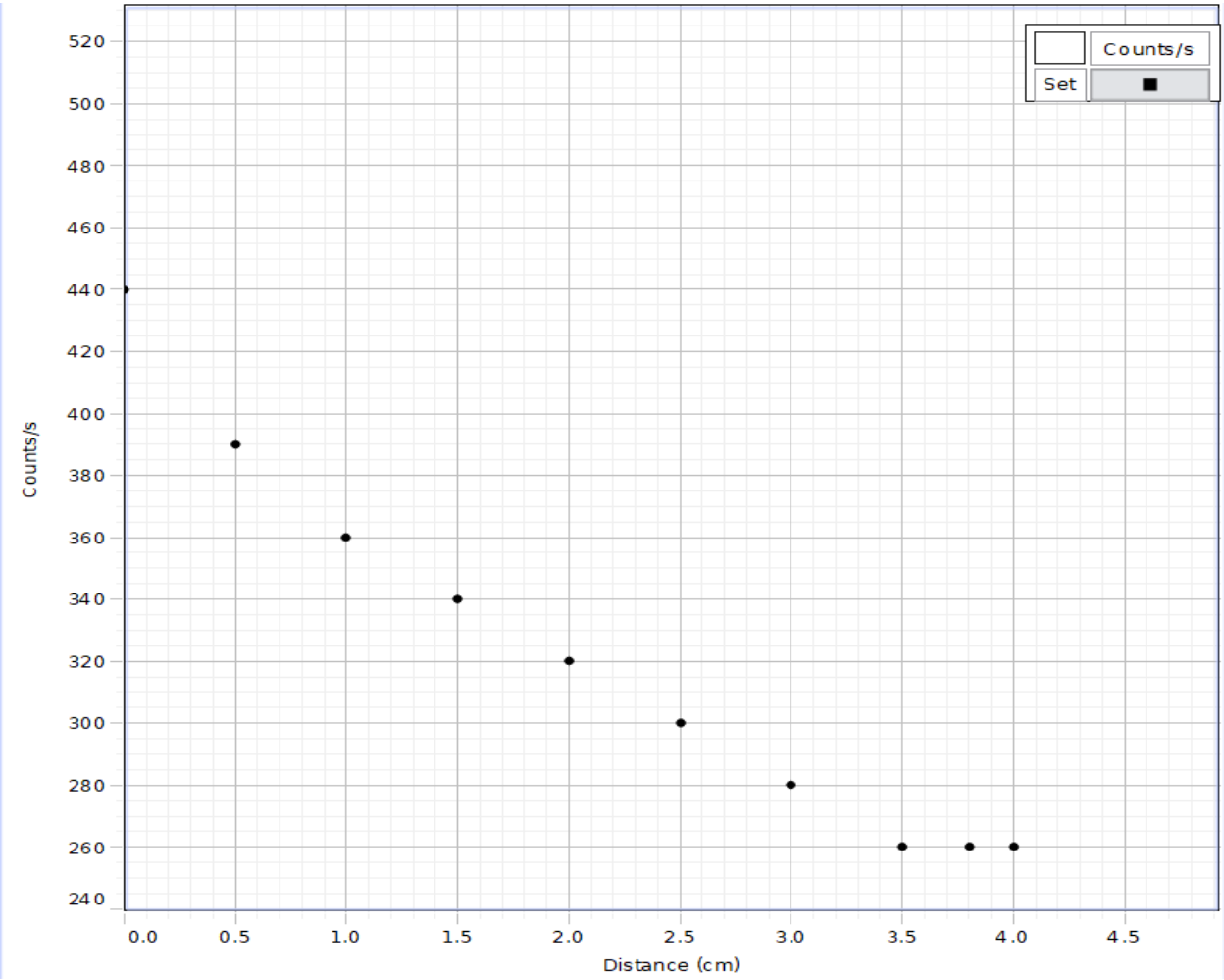
Thickness (cm)	I/I0
0.00	1.00000
0.20	0.73931
0.25	0.73570
0.40	0.68065
0.80	0.58611
1.00	0.53827
1.20	0.48042



The attenuation coefficient of Cu is 0.628

TASK 5: ALPHA RANGE IN THE AIR

Distance (cm)	Counts/s
0.0	440
0.5	390
1.0	360
1.5	340
2.0	320
2.5	300
3.0	280
3.5	260
3.8	260
4.0	260



We noticed that the no. of counts per second decreased substantially at distance equal to 3.5 cm. the no. of counts doesn't go to zero due to background radiation.