INTEREST – International Remote Student Training Wave 3

Radiation Protection and the Safety of Radiation Sources

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Task 1: The Bismuth Germanium Oxide (BGO) detector

. Its scintillation properties allow the subsequent detection of the absorbed radiation, as it is an important tool for the detection of (p, γ) reactions.

Required:

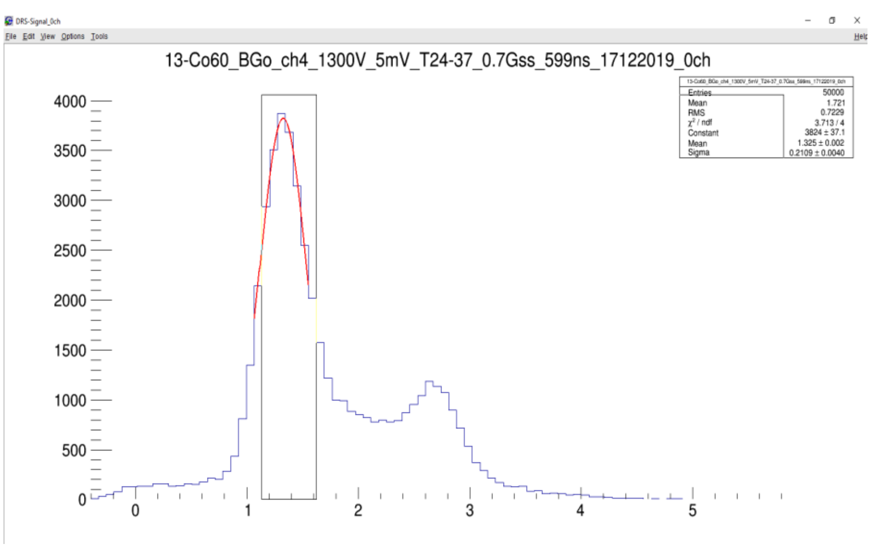
1- Dependence of resolution on the applied voltage for BGO detector

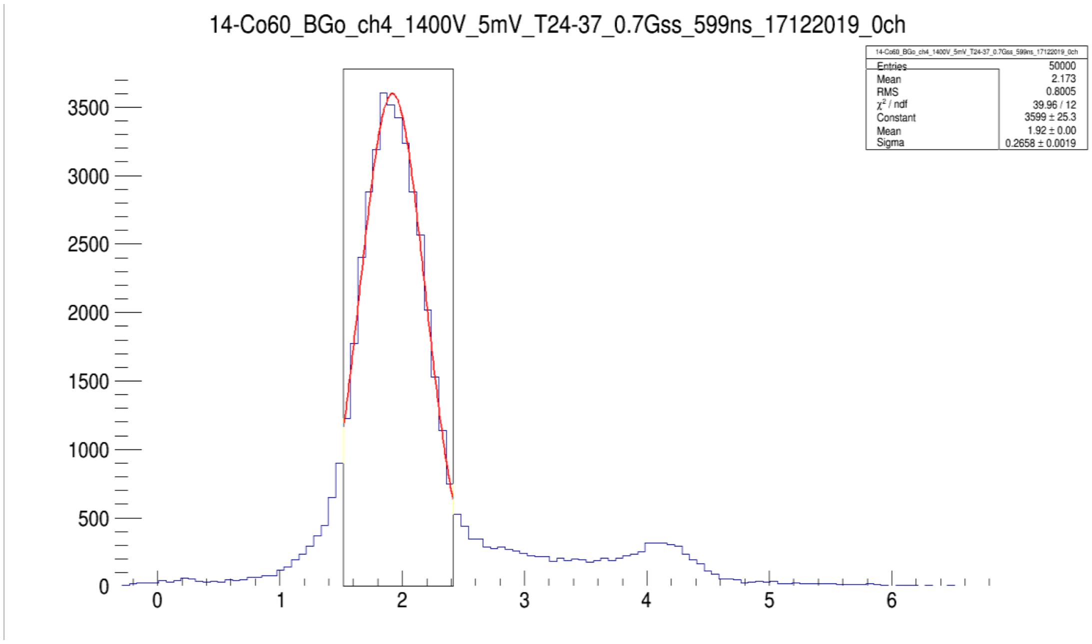
2-The calibration spectra for BGO detector

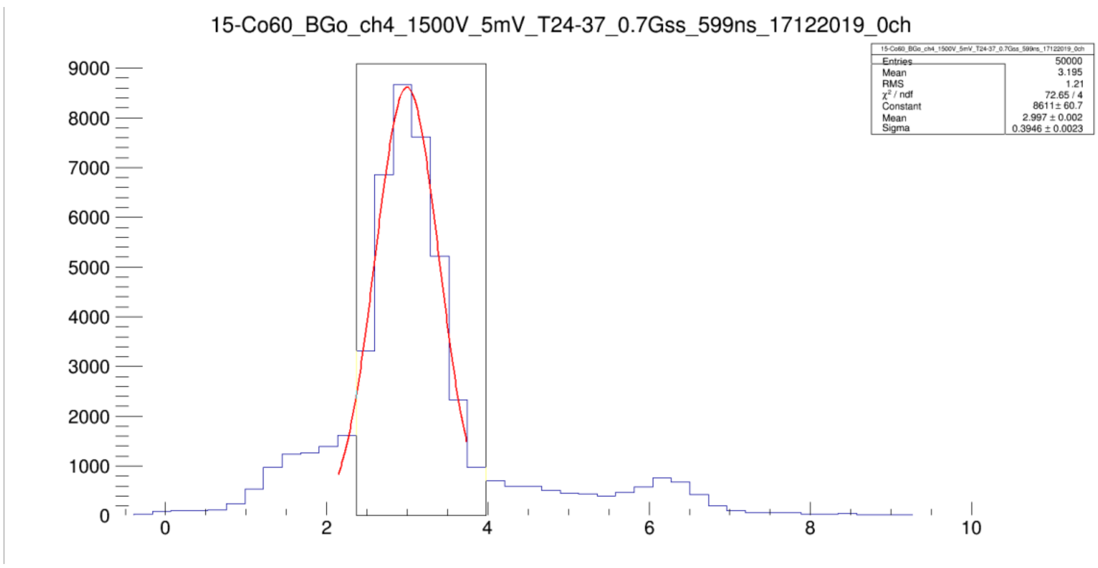
Task 1:

The energy resolution (Re) of a detector measures its ability to distinguish gamma-rays with close energies. The better the energy resolution, the better it can separate two adjacent energy peaks, which allows identifying different decays or radionuclides in the spectrum. Re is obtained from the peak full width at half of the maximum height (FWHM)

Re= (Sigma*2.35)/mean




14-Co60_BGo_ch4_1400V_5mV_T24-37_0.7Gss_599ns_17122019_0ch
Entries 50000
Mean 2.173
RMS 0.8005
χ² / ndf 39.96 / 12
Constant 3599 ± 25.3
Mean 1.92 ± 0.00
Sigma 0.2658 ± 0.0019
3500
3000
2500
2000
1500
1000
500
0
0 1 2 3 4 5 6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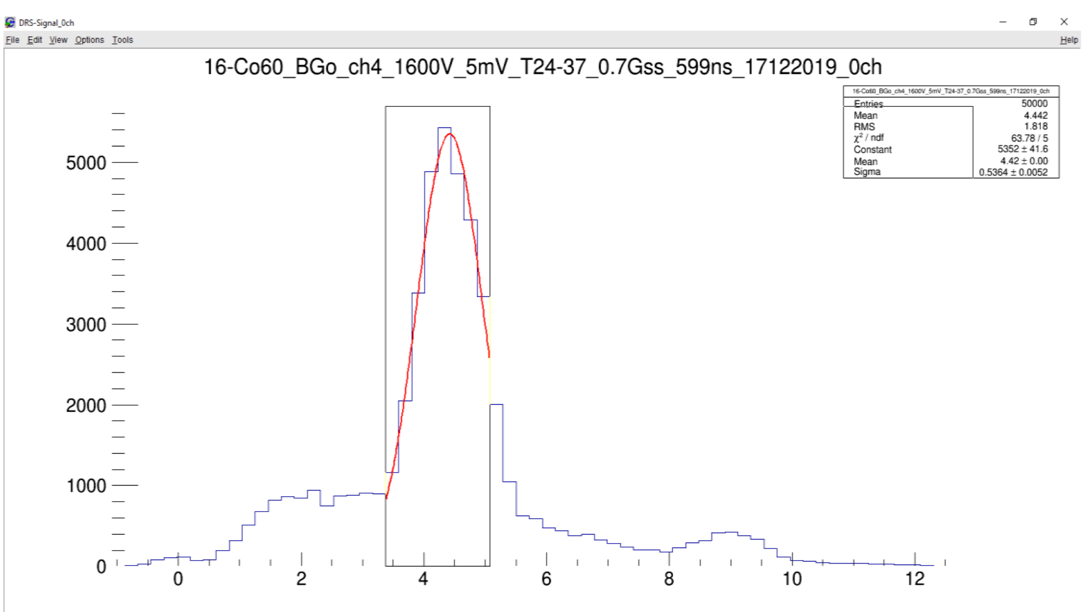
Entries 50000
Mean 3.195
RMS 1.21
χ² / ndf 72.65 / 4
Constant 8611± 60.7
Mean 2.997 ± 0.002
Sigma 0.3946 ± 0.0023
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0 2 4 6 8 10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File Edit View Options Tools
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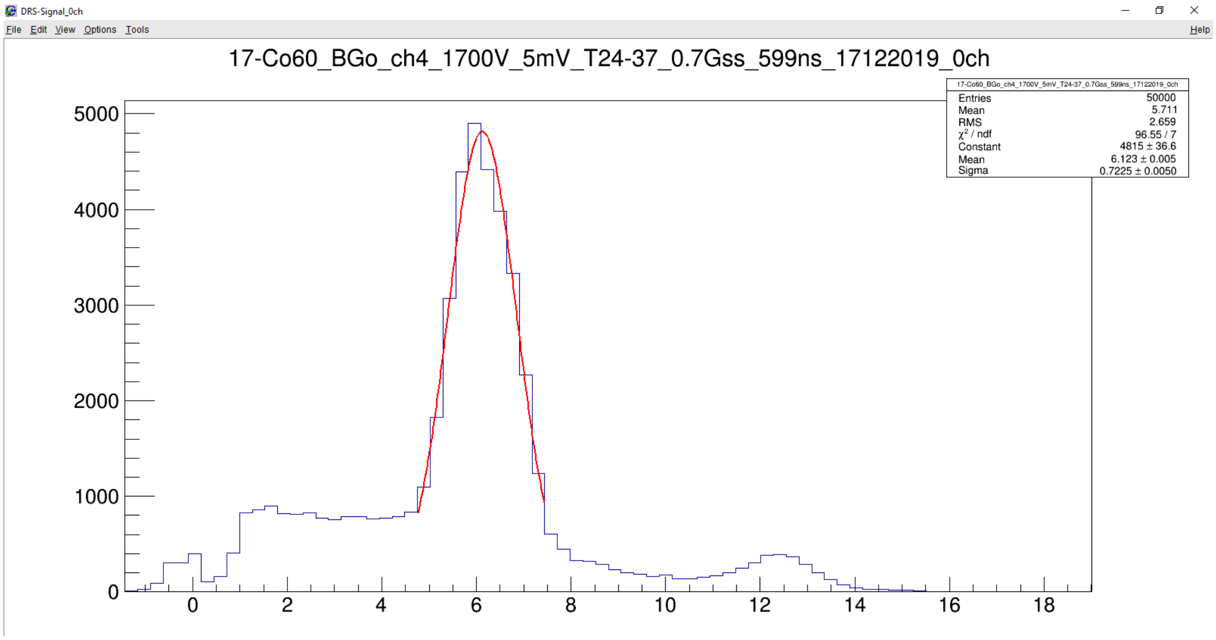
16-Co60_BGo_ch4_1600V_5mV_T24-37_0.7Gss_599ns_17122019_0ch
Entries 50000
Mean 4.442
RMS 1.818
χ² / ndf 63.78 / 5
Constant 5352 ± 41.6
Mean 4.42 ± 0.00
Sigma 0.5364 ± 0.0052
5000
4000
3000
2000
1000
0
0 2 4 6 8 10 12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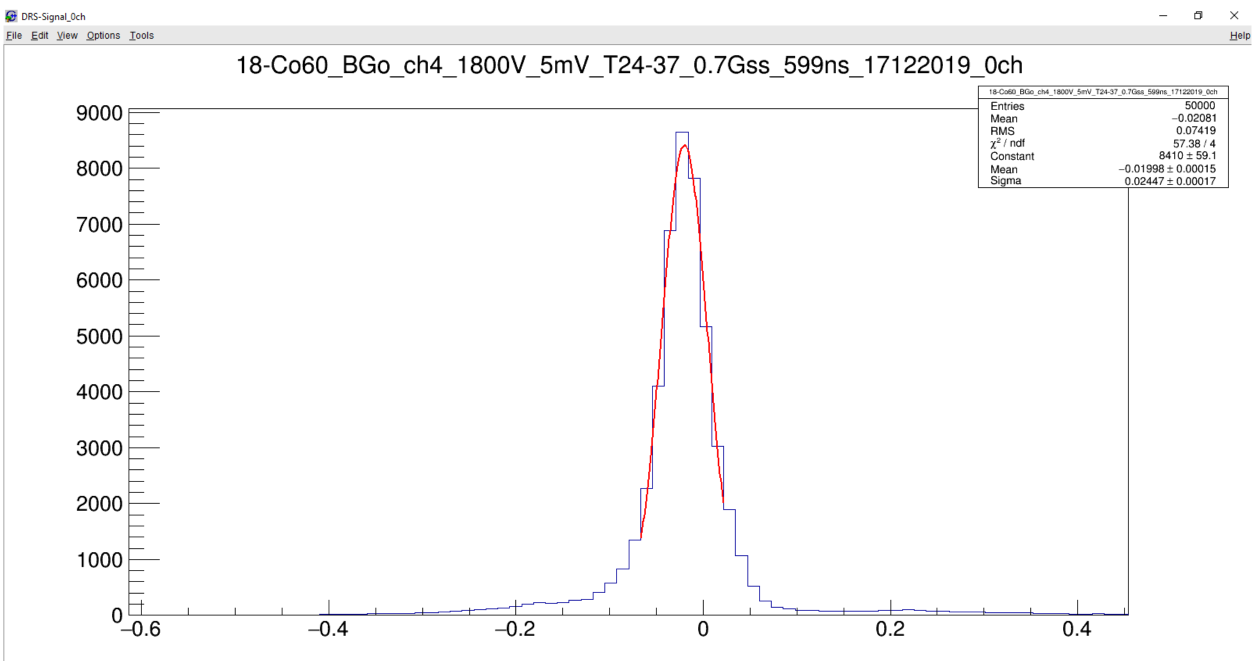
Entries 50000
Mean 5.711
RMS 2.659
χ² / ndf 96.55 / 7
Constant 4815 ± 36.6
Mean 6.123 ± 0.005
Sigma 0.7225 ± 0.0050
0 1000 2000 3000 4000 5000
0 2 4 6 8 10 12 14 16 18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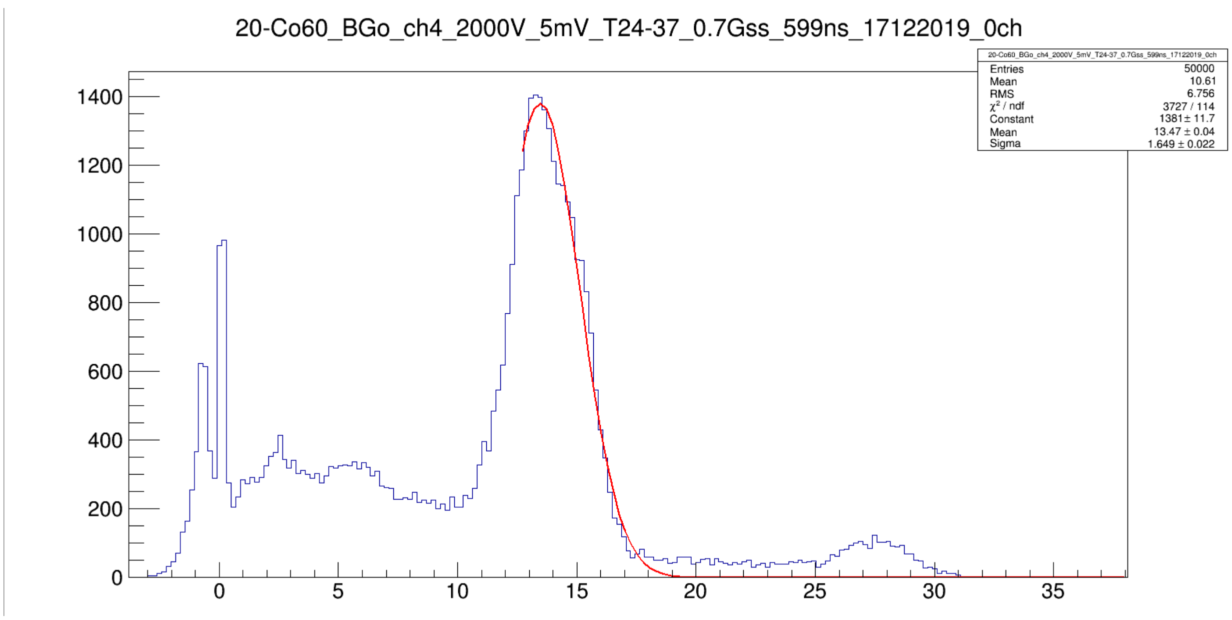
Entries 50000
Mean −0.02081
RMS 0.07419
χ² / ndf 57.38 / 4
Constant 8410 ± 59.1
Mean −0.01998 ± 0.00015
Sigma 0.02447 ± 0.00017
0 1000 2000 3000 4000 5000 6000 7000 8000 9000
−0.6 −0.4 −0.2 0 0.2 0.4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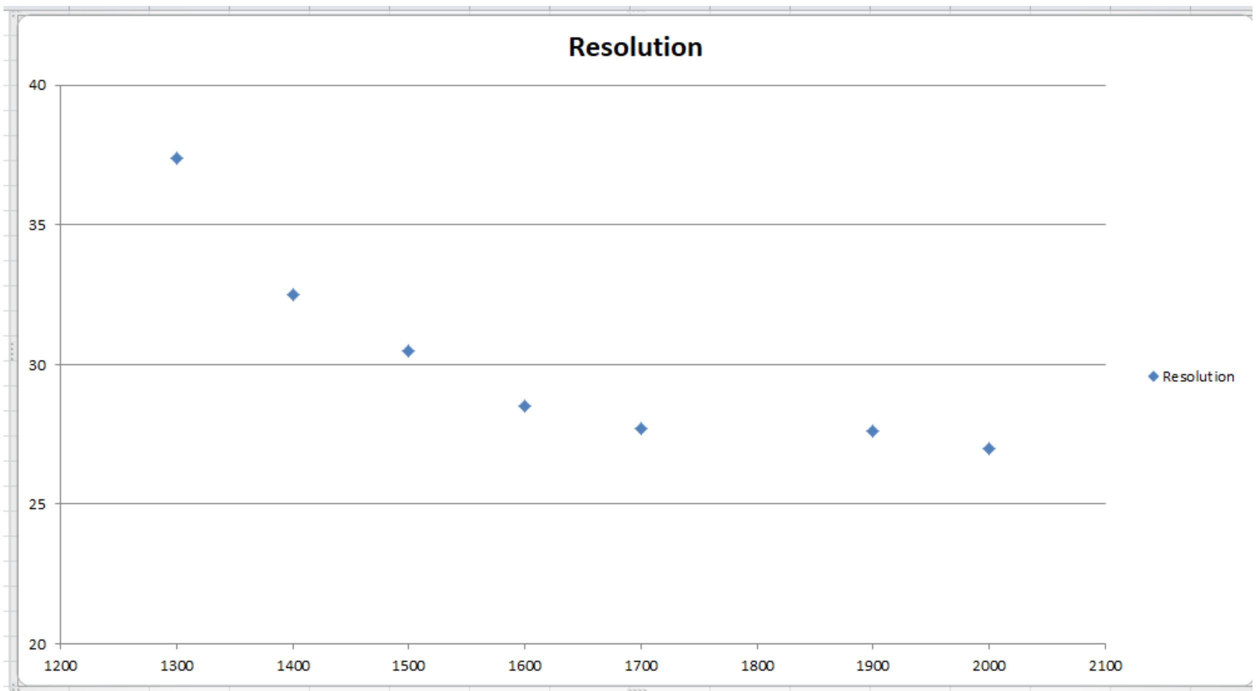
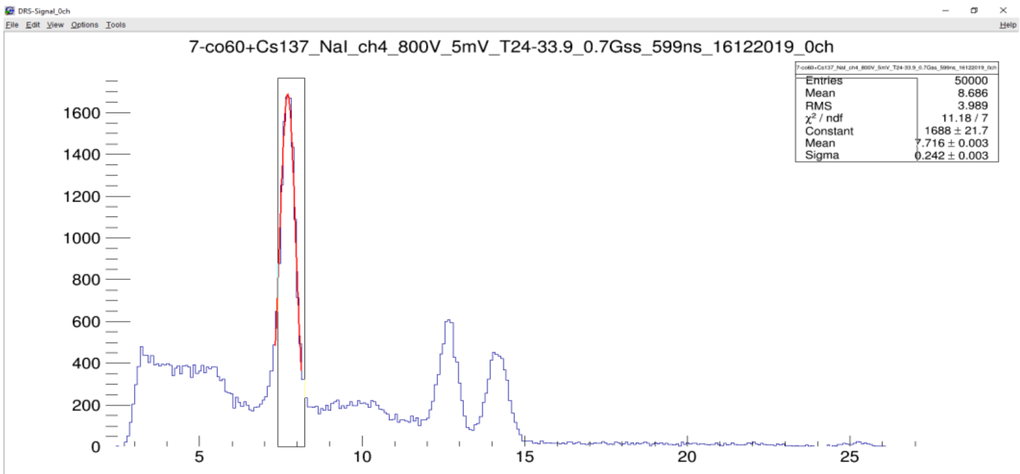
Entries 50000
Mean 10.61
RMS 6.756
χ² / ndf 3727 / 114
Constant 1381 ± 11.7
Mean 13.47 ± 0.04
Sigma 1.649 ± 0.022
0 200 400 600 800 1000 1200 1400
0 5 10 15 20 25 30 35

Applied volt	1300	1400	1500	1600	1700	1800	1900	2000
Resolution%	37.4	32.5	30.9	28.51	27.7	-	27.6	27.1

- The graph between the resolution on the y axis and the applied voltage on the x axis



NaI calibration



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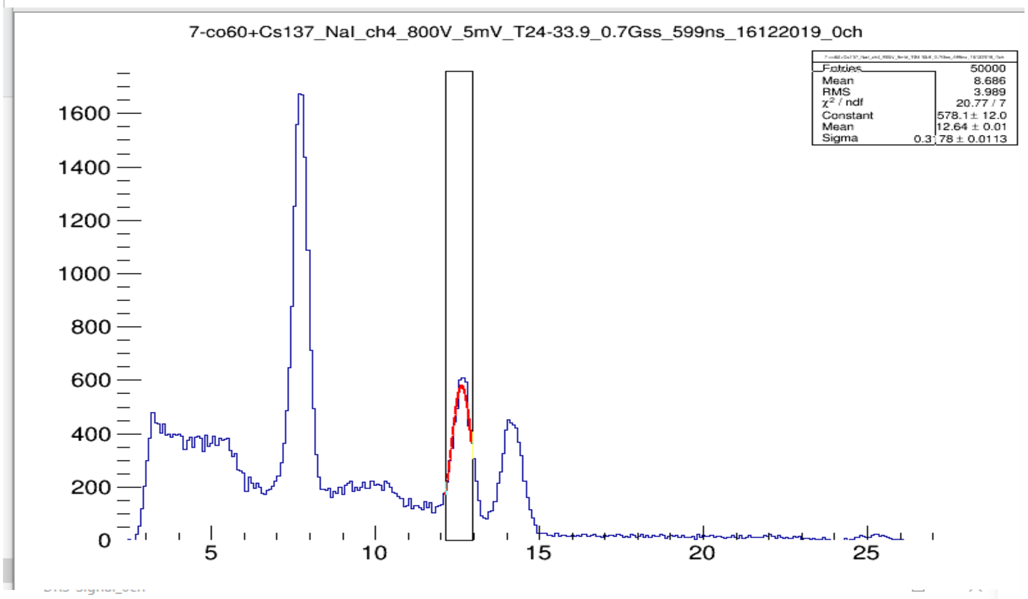

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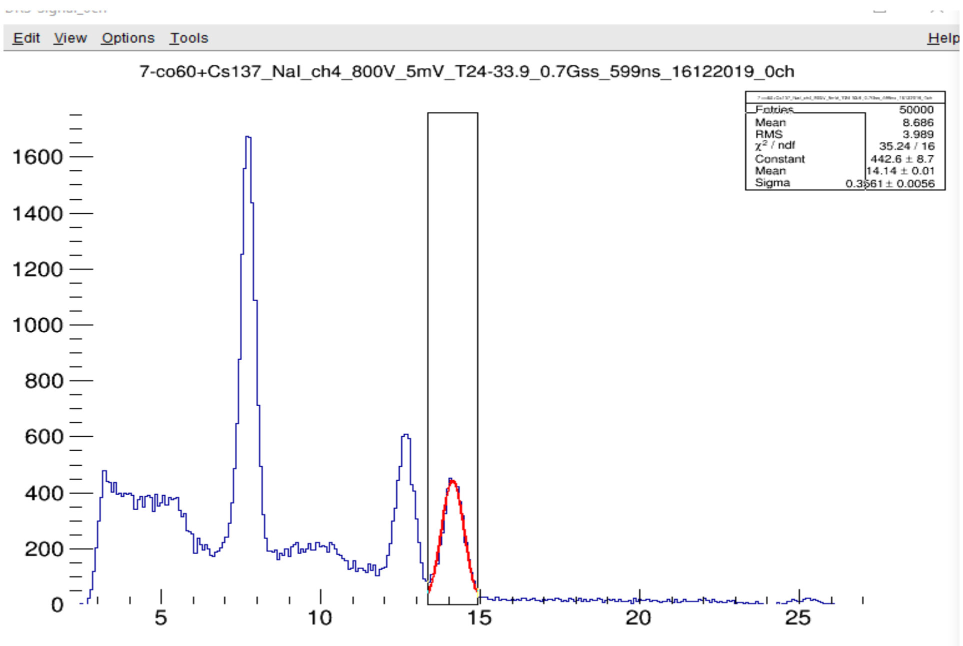

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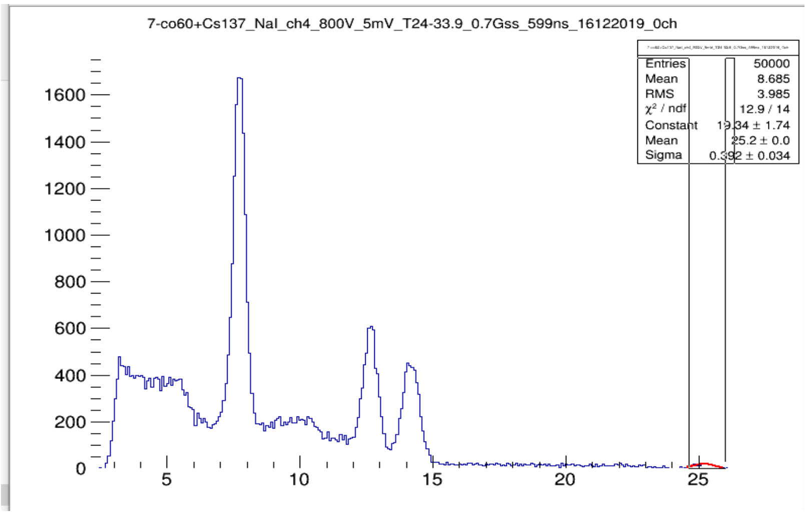
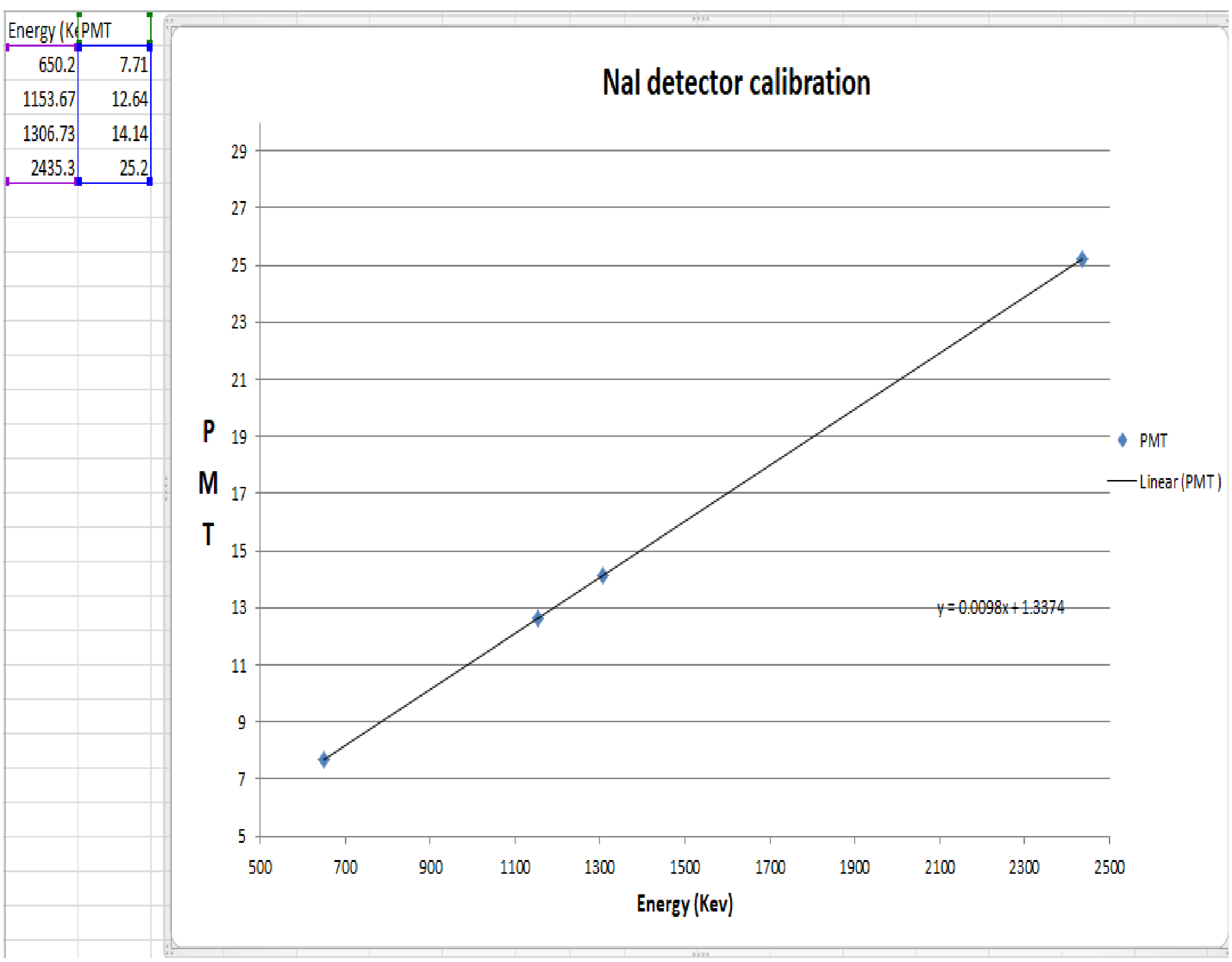
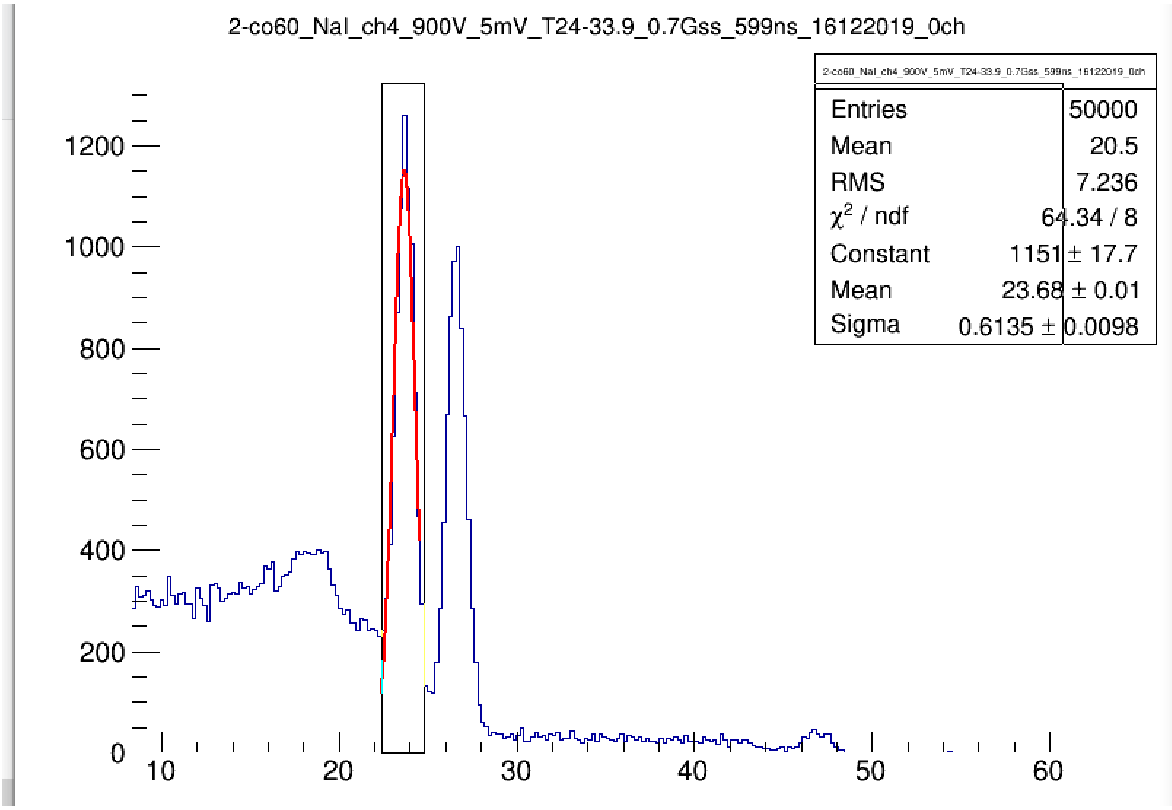


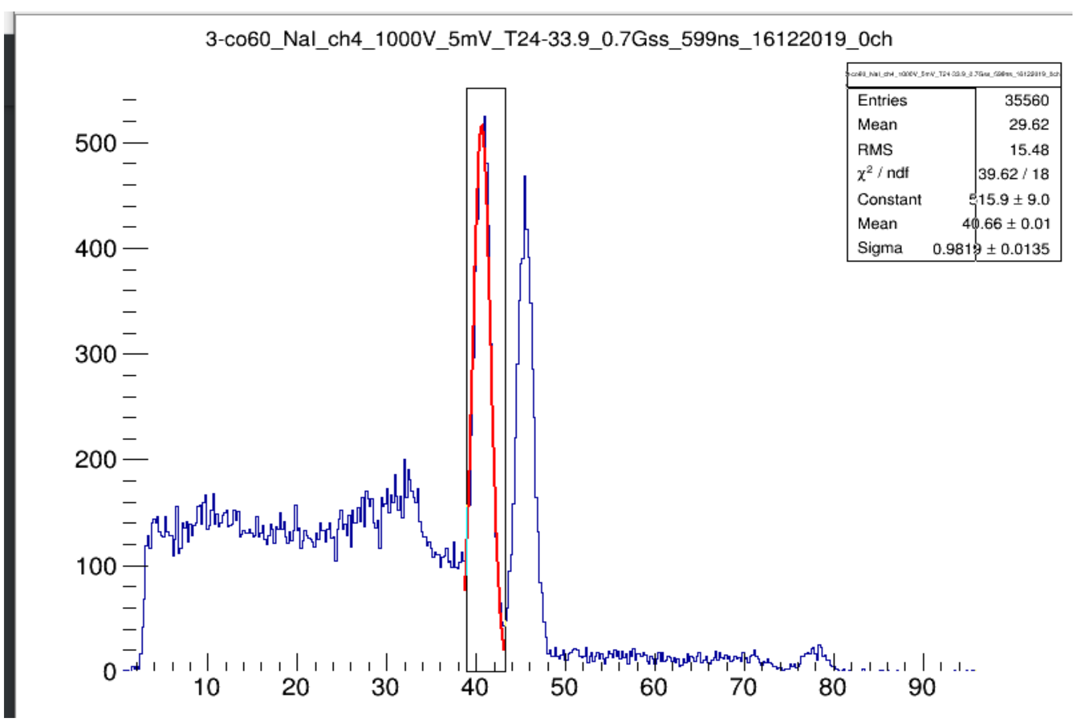
4

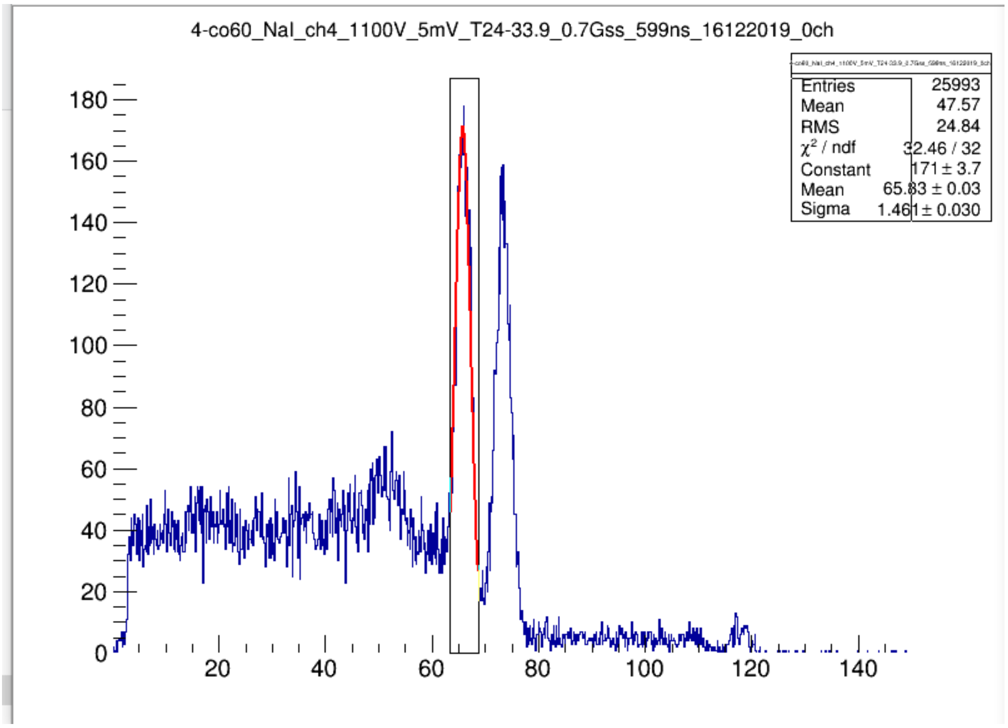
Peak n	1	2	3	4
PMT	7.71	12.64	14.14	25.2
Energy(Kev)	650.2	1153.67	1306.73	2435.30

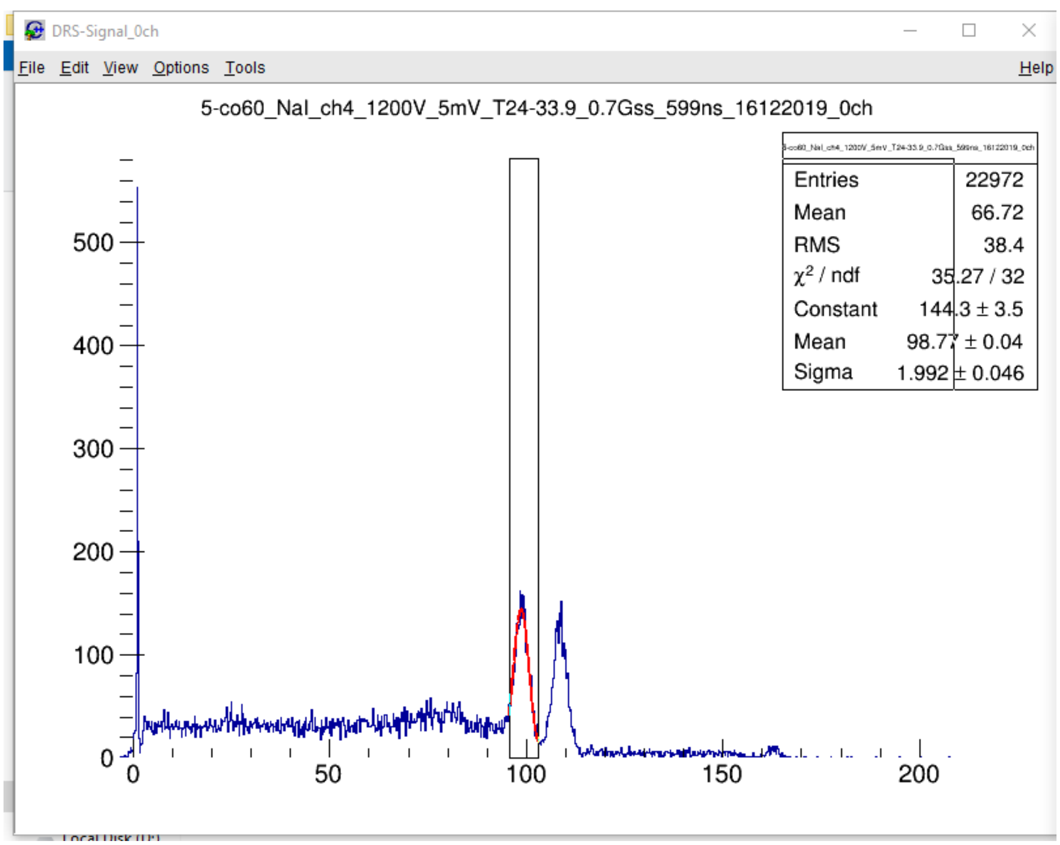


NaI resolution:






4-co60_NaI_ch4_1100V_5mV_T24-33.9_0.7Gss_599ns_16122019_0ch
Entries 25993
Mean 47.57
RMS 24.84
χ² / ndf 32.46 / 32
Constant 171 ± 3.7
Mean 65.83 ± 0.03
Sigma 1.461 ± 0.030
180
160
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140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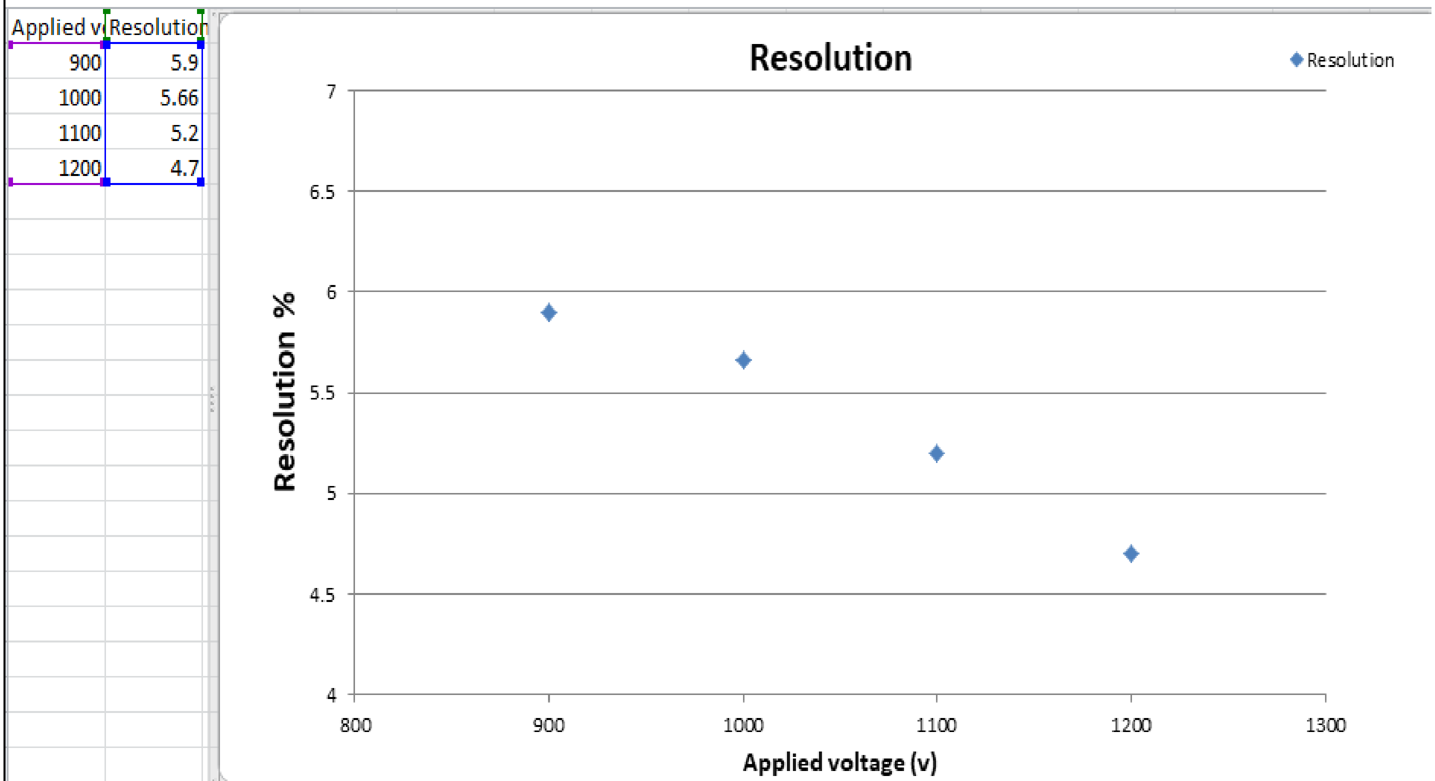
File Edit View Options Tools Help
5-co60_NaI_ch4_1200V_5mV_T24-33.9_0.7Gss_599ns_16122019_0ch
Entries 22972
Mean 66.72
RMS 38.4
χ² / ndf 35.27 / 32
Constant 144.3 ± 3.5
Mean 98.77 ± 0.04
Sigma 1.992 ± 0.046
500
400
300
200
100
0
0
50
100
150
200

Applied volt	900	1000	1100	1200
Resolution %	5.9	5.67	5.2	4.7



Attenuation coefficient

➢ I=Io$* e^{-\mu x}$

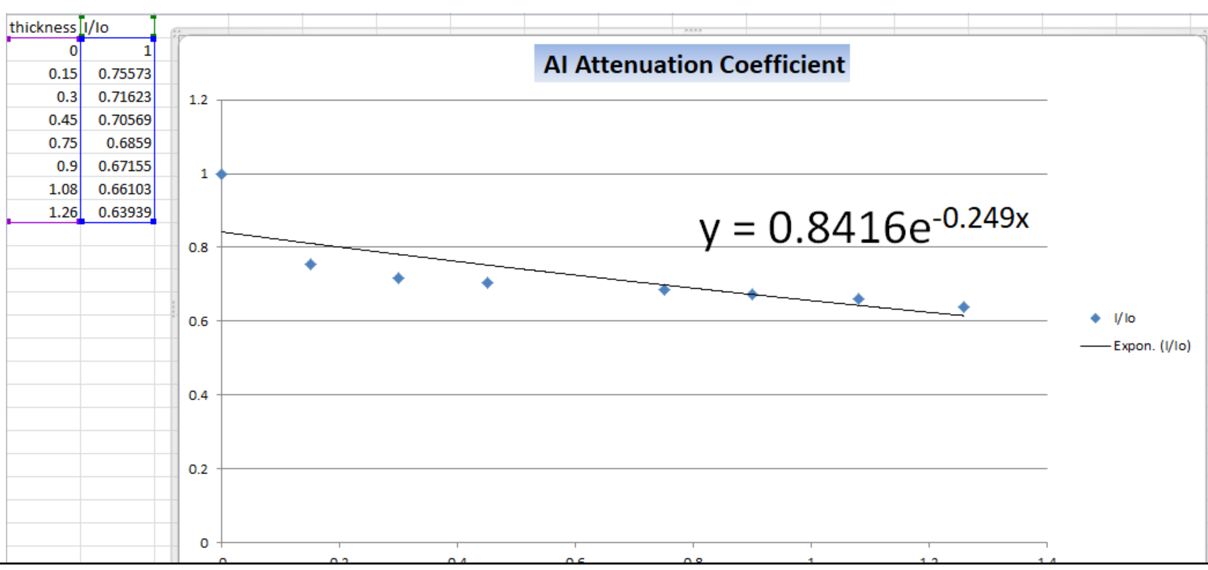
- ## First Al

Thickness(cm)	I/Io
0	1
0.15	0.75573
0.3	0.71623
0.45	0.70569
0.75	0.68596
0.9	0.67155
1.08	0.66103
1.26	0.63939

µ=slope,   µ for Al=0.2

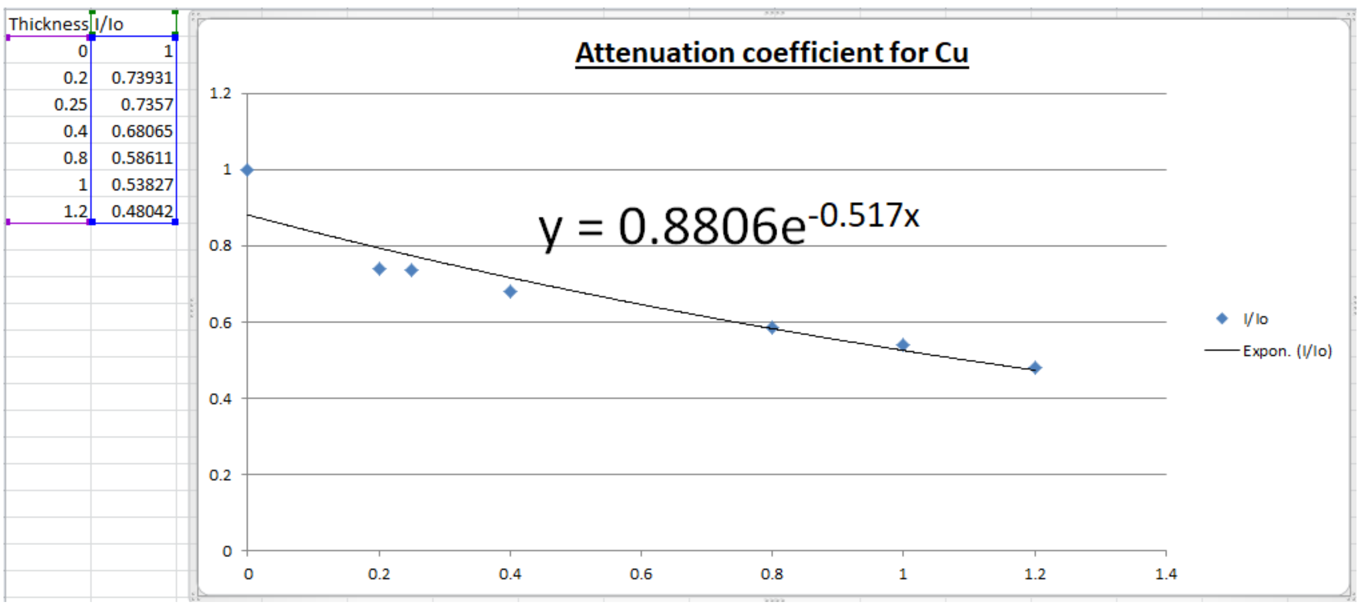
From this we can obtain the Mass Attenuation Coefficient:

Given that mass attenuation coefficient can be obtainedfrom the mathematical formula: $\frac{\mu}{Dinsety}$



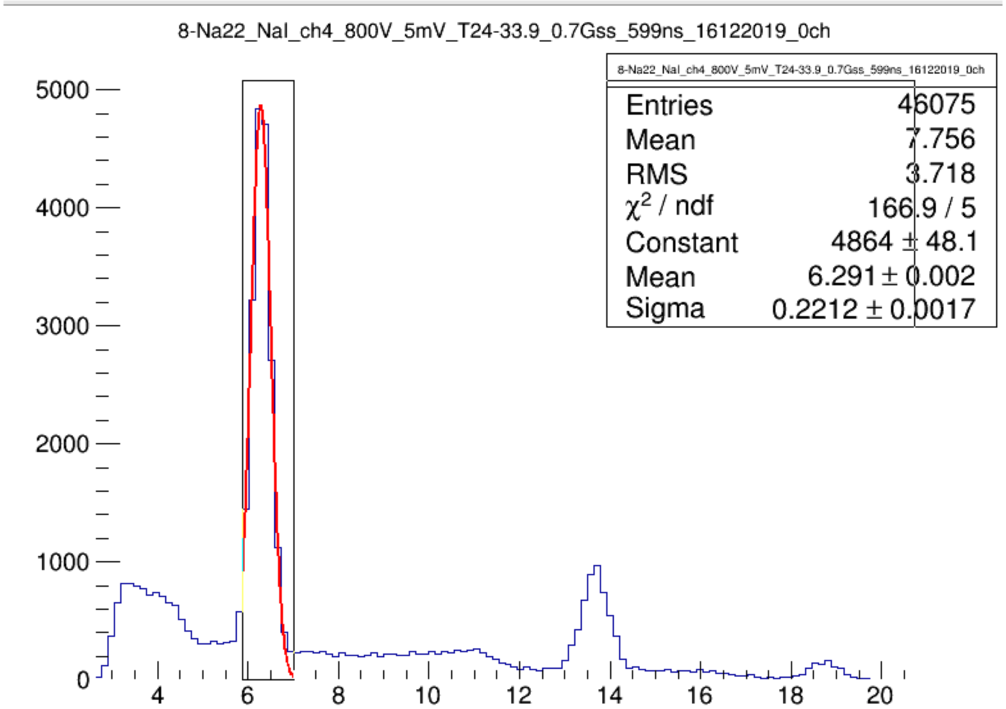
- **<u>For Cu</u>**

Thickness(cm)	I/Io
0	1
0.2	0.73931
0.25	0.7357
0.4	0.68065
0.8	0.58611
1	0.53827
1.2	0.48042



<u>μ=0.5</u>

- ***<u>The identification of unknown sources</u>***



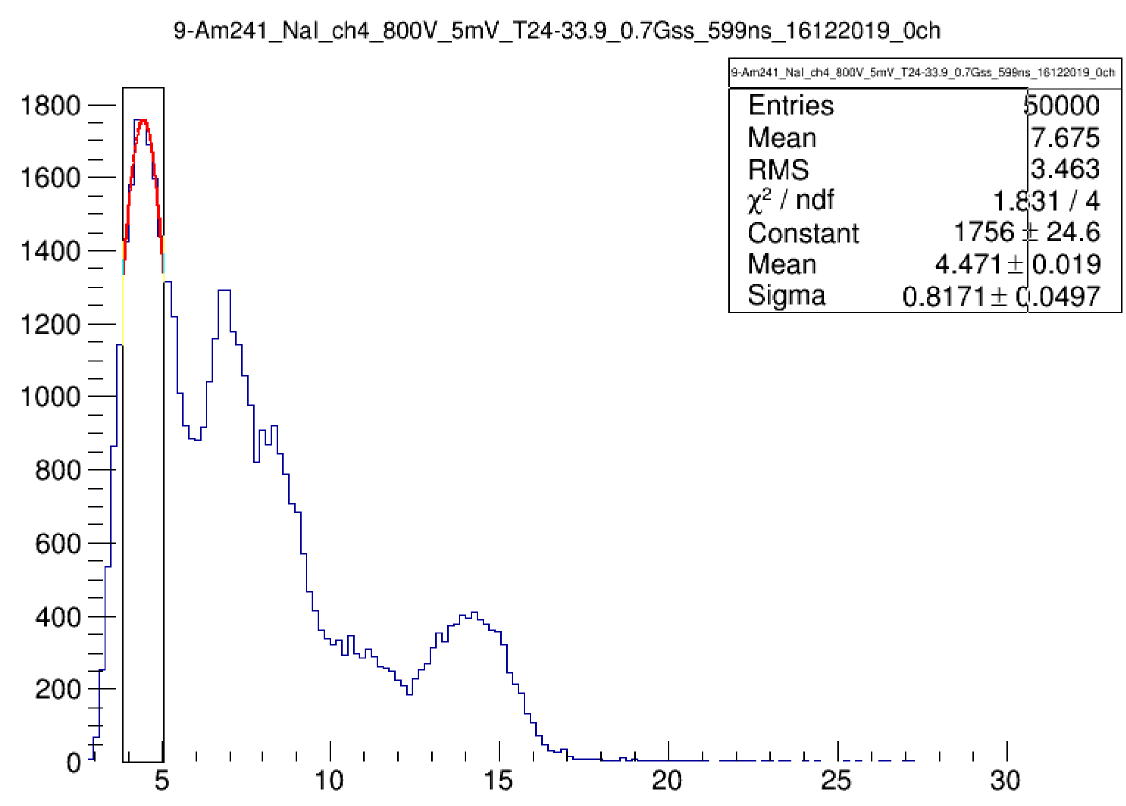
Mean=6.291

From the equation y=0.0098x+1.3374

Substituting in the last equation mean=y

From that we get x=505.46

E=505.46 Kev.



Mean=4.471

From the equation y=0.0098x+1.3374

Substituting in the last equation mean=y

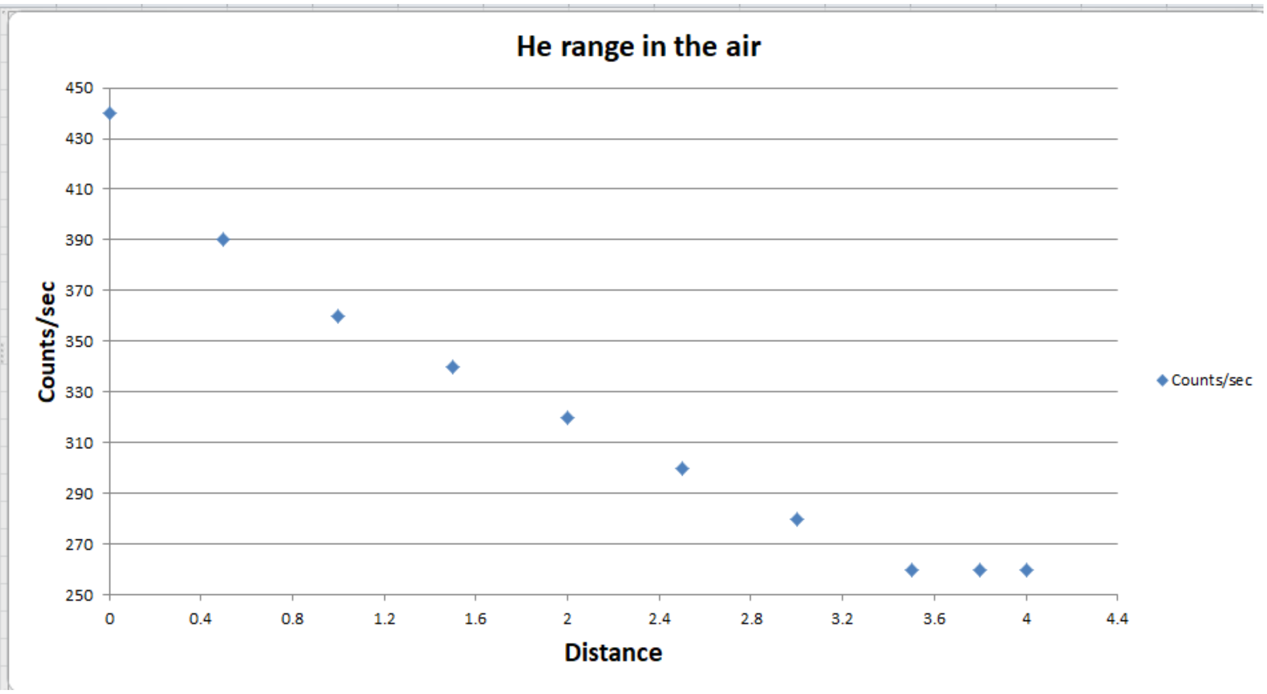
From that we get x=319.7

- E=319.7Kev

Determine the range of He in the air

- Source Pu239
- Detector Plastic
- Applied voltage 2000V

Distance	Counts/sec
0	440
0.5	390
1	360
1.5	340
2	320
2.5	300
3	280
3.5	260
3.8	260
4	260



After a certain distance which here equal to 3.5 cm we find that the counts/sec is constant so from that we conclude that the range of alpha in the air =3.5 cm

Pixel detector task

Contents:

1- An overview of **pixel detector**, its uses and importance.
2- Determination the **range of Alpha particles** with (Am241) energy about 4 MeV in air using pixel detector.

Pixel detectors: First pixel detectors in HEP were CCDs derived from digital cameras, as it is a very advanced detector that consists of main three parts:

1- Sensor (which can be Si or germanium arsenide)
2- - Electronic chip
3- USB

- The size of the sensor is 1.5x1.5 cm.

- It has 256 x 256 pixels (65.536 pixels).

- The pixel size is 55μm x 55μm.

2. Determination the range of Alpha particles with (Am241) energy about 4 MeV in air using pixel detector

Alpha particles travel in nearly straight paths because they are thousands of times heavier than the atomic electrons to which they gradually lose energy, so in our experiment we will determine their **range** in the air using pixel detector as we will vary the distance between the detector and the alpha source till there is no alpha particle detected, from this distance we obtain our maximum range which will be **<u>about 3 cm</u>**

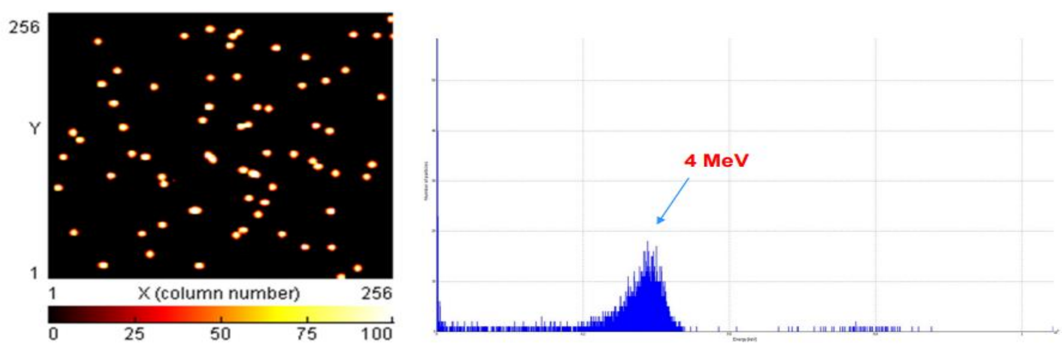
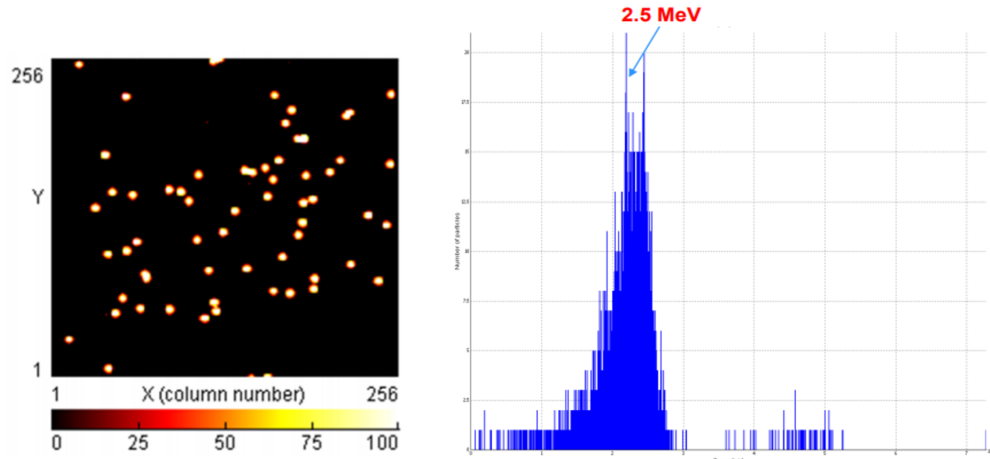


Fig. (15.a)

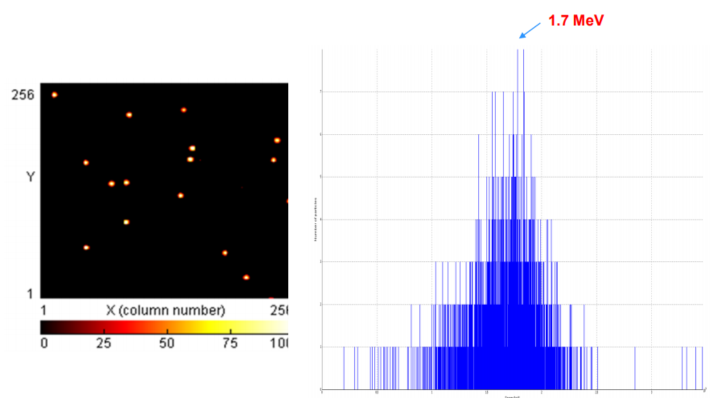
- ***Absorption of alpha particle energy in the air at zero cm***

As you see the alpha particles still have 4 Mev at 0 cm from the source,

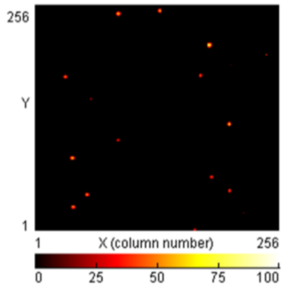
Now let's see the changes at 1cm:

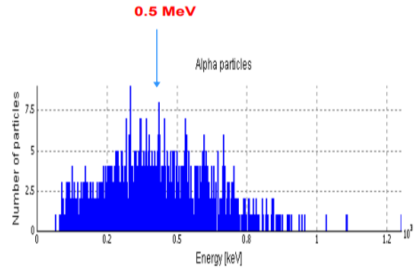


Now some of the energy has been absorbed in the air, and the alpha energy will keep decreasing with increasing our distance, with repeating the previous step at different distances (2, 2.5 cm) at 3 cm the detector is no longer finding any alpha particle, and from that we conclude that **Maximum of alpha particle range is 3 cm**



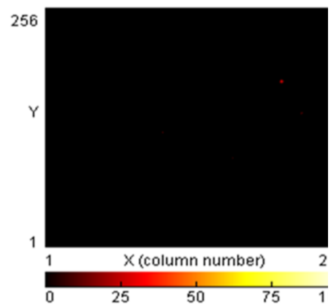
Absorption of alpha particle energy in the air by moving the alpha source away by 2 cm





Absorption of alpha particle energy in the air
by moving the alpha source away by 2.5 cm

no alpha particles are detected



Maximum of alpha particle range is 3 cm