“Radiation Protection and the Safety of the Radiation Sources”

INTEREST 7th Wave (13 June - 22 July)

By:

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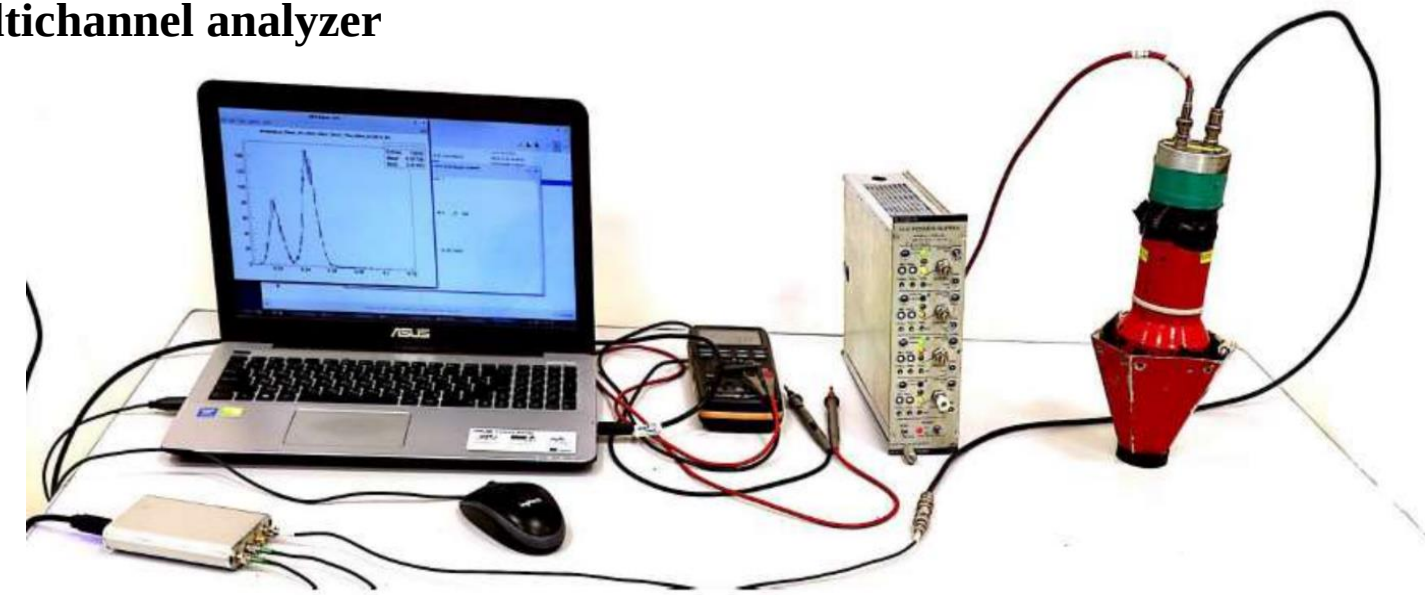
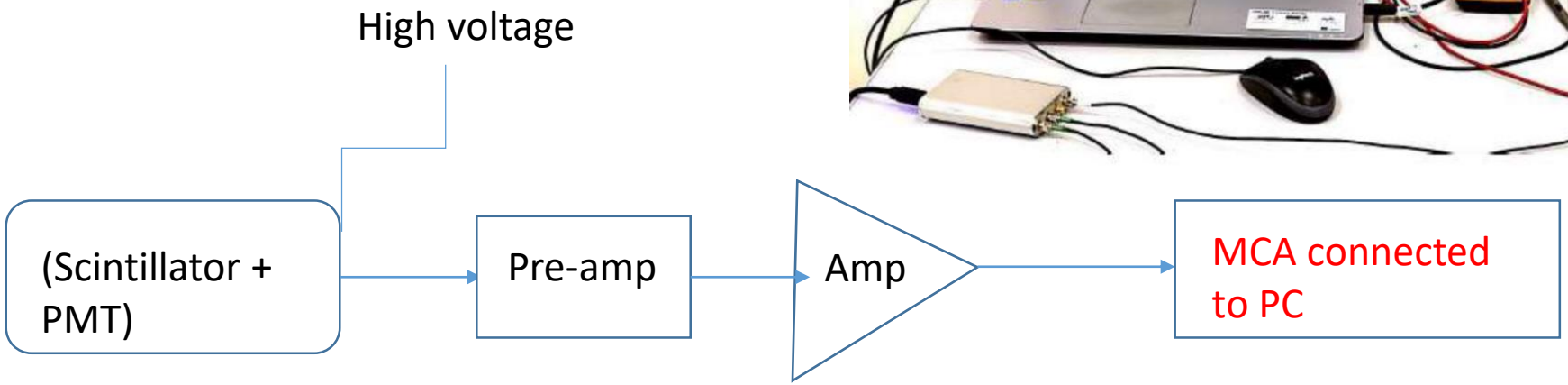
Scintillation detectors

We used two types of Scintillations Detectors, BGO and NaI(Ti) scintillation crystals.
Scintillation detectors consist of scintillator crystal, photomultiplier tube (PMT) connected to high voltage and the signals are amplified and received on multichannel analyzer





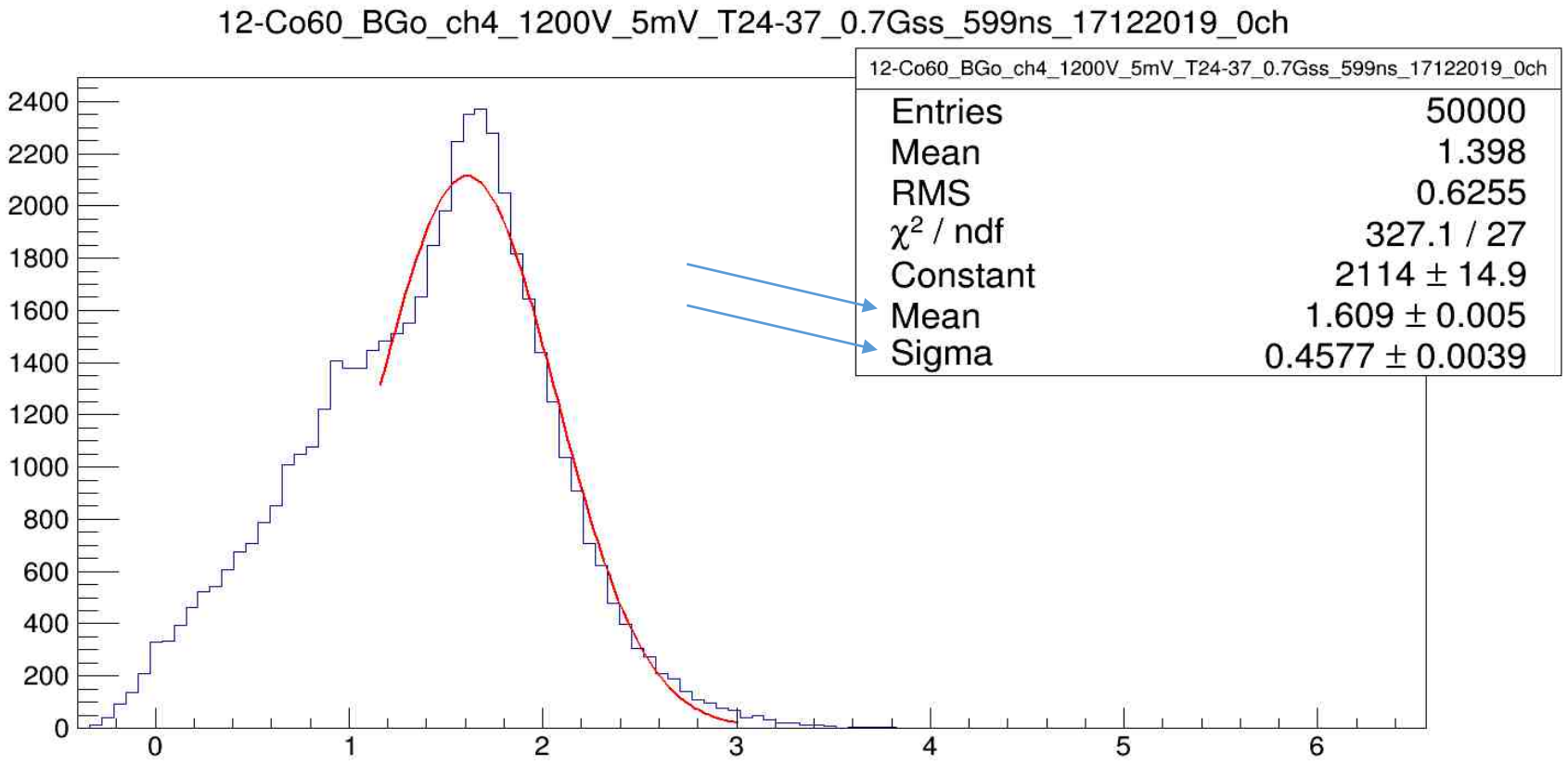
Resolution of BGO

Testing the Resolution of the BGO detector when operating using different applied voltage:

When increasing the voltage from 1200 V to 2000 V, The percentage resolution values were calculated using the equation:

R(%)= (σ/Mean)*2.35*100 While *σ and Mean are fitting parameters*

Fitting to get σ and Mean:

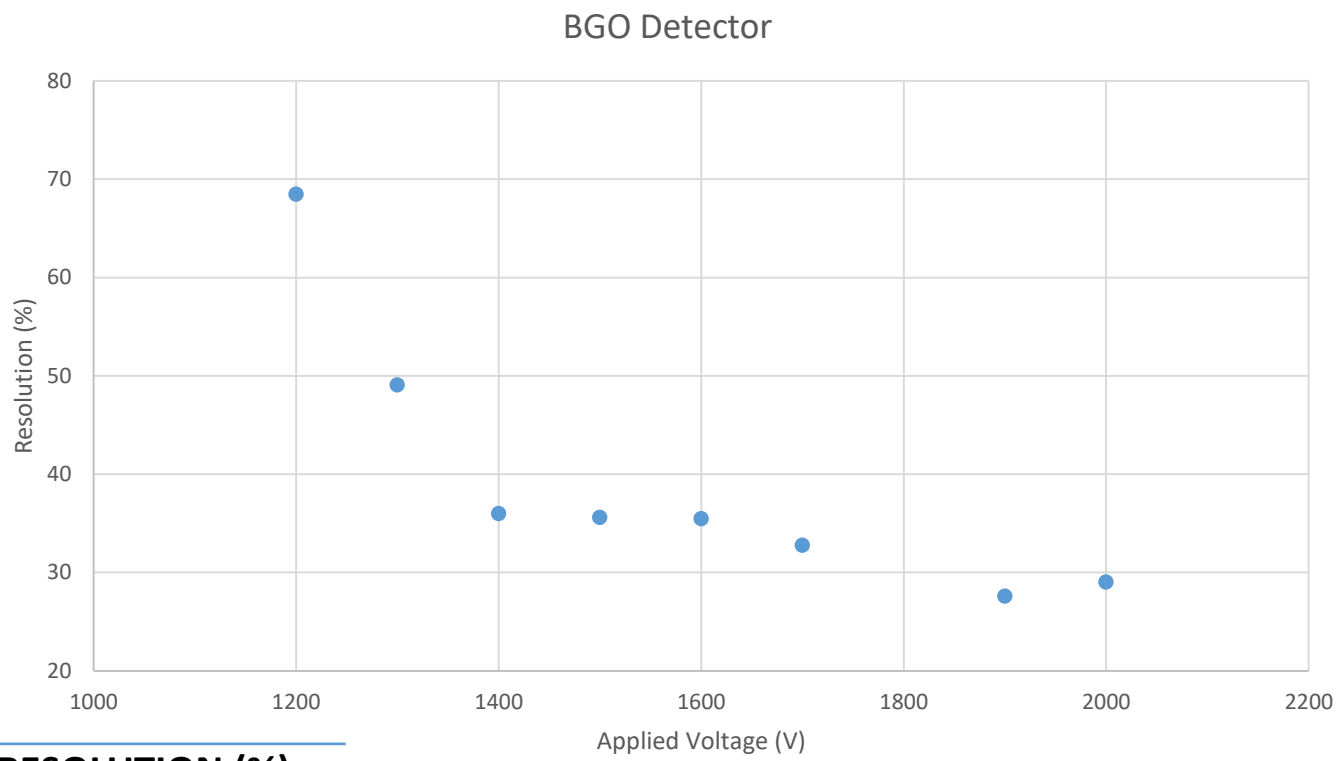


The relation between Resolution (%) Vs. Applied voltage (V)

After getting the values of σ and Mean

Substitute in this formula:

$$R(\%) = (\sigma/Mean)*2.35*100$$

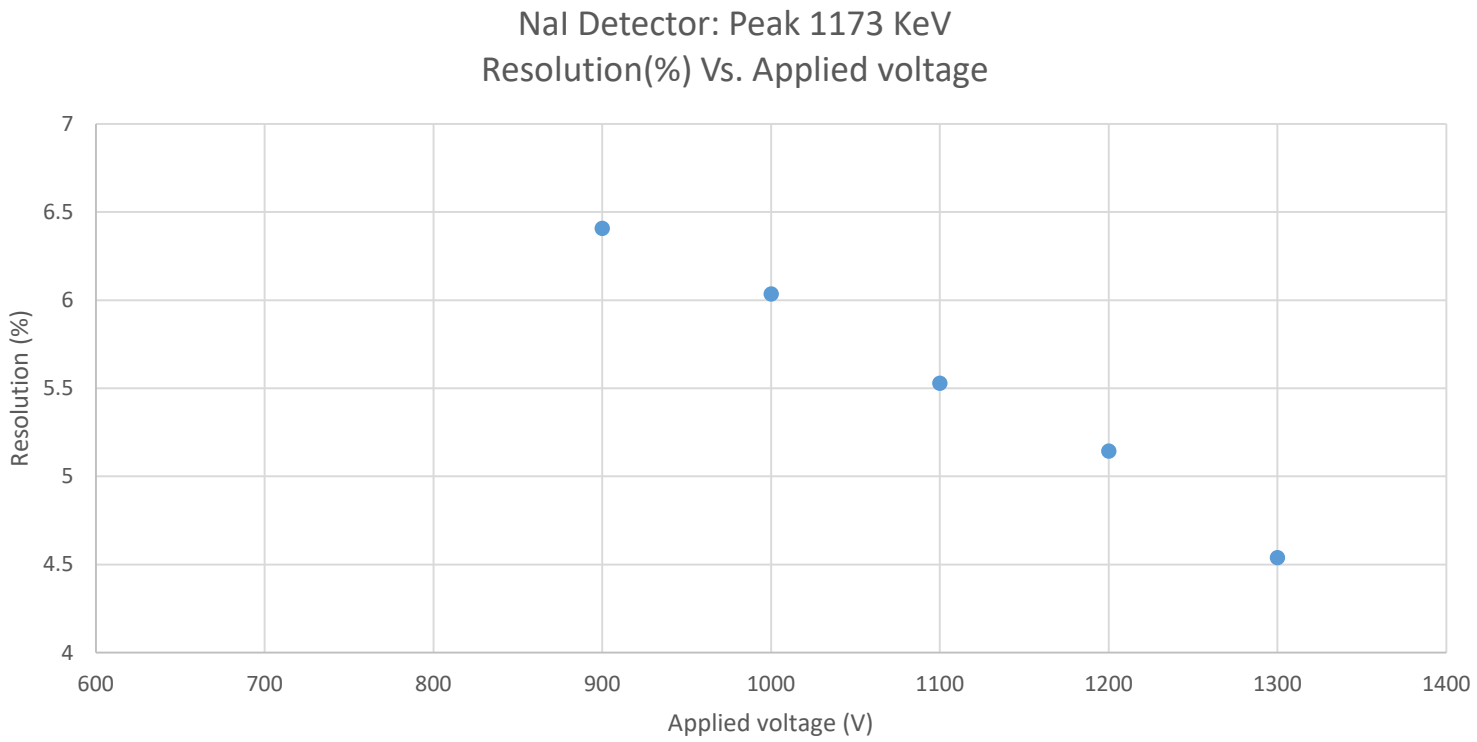


No.	Mean	Sigma	Applied voltage (V)	RESOLUTION (%)
1	1.6029	0.467104	1200	68.48177678
2	1.3994	0.292262	1300	49.07929827
3	1.924	0.2948	1400	36.00727651
4	2.9889	0.4528	1500	35.60105725
5	4.401	0.6646	1600	35.48761645
6	6.0835	0.8488	1700	32.78836196
7	10.67	1.2539	1900	27.61635426
8	13.55	1.674	2000	29.03247232

NaI Detector:

Resolution Vs. applied voltage for The first peak (1173 KeV)

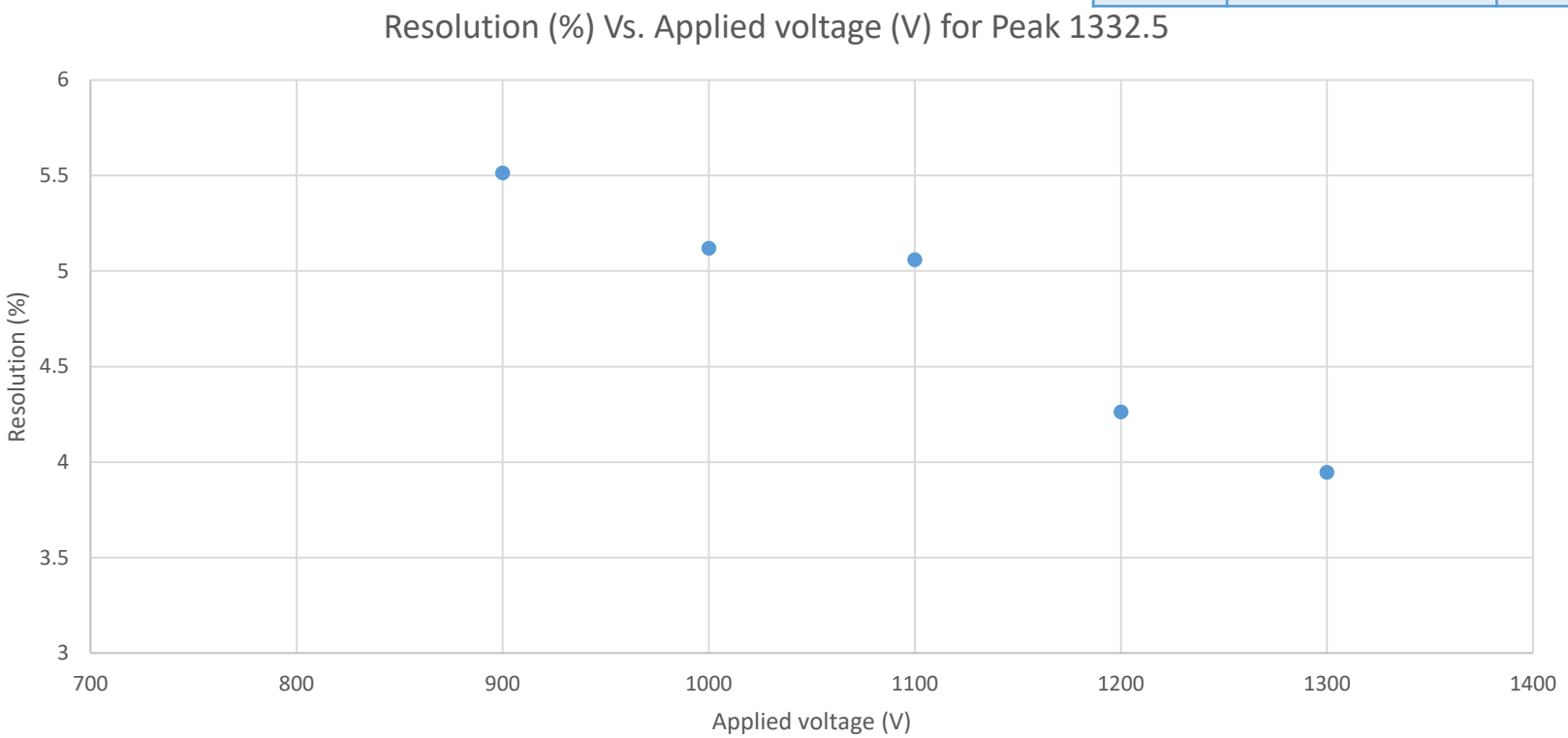
No.	Mean	Sigma	Applied voltage	RESOLUTION(%)
1	23.65	0.6448	900	6.407103594
2	40.61	1.043	1000	6.035582369
3	65.76	1.547	1100	5.528360706
4	98.65	2.159	1200	5.143081602
5	137.4	2.654	1300	4.53922853



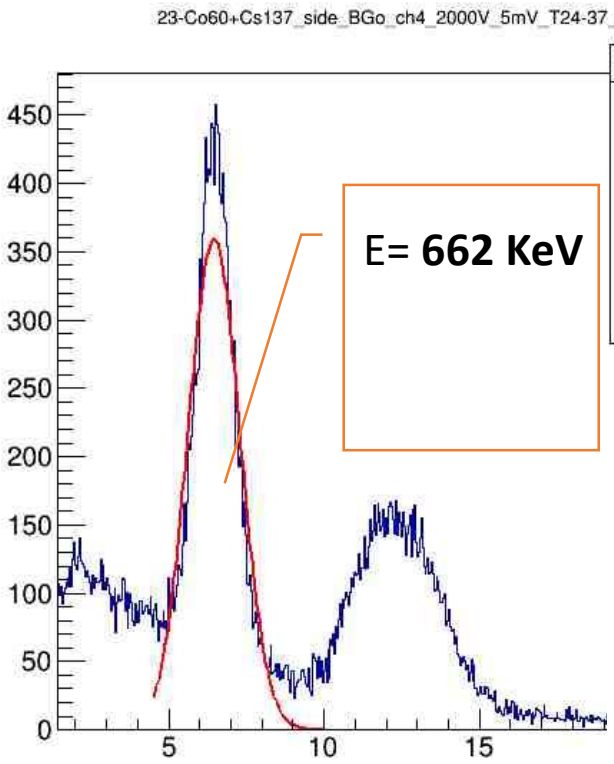
NaI Detector:

Resolution Vs. applied voltage for The second peak (1332.5 KeV)

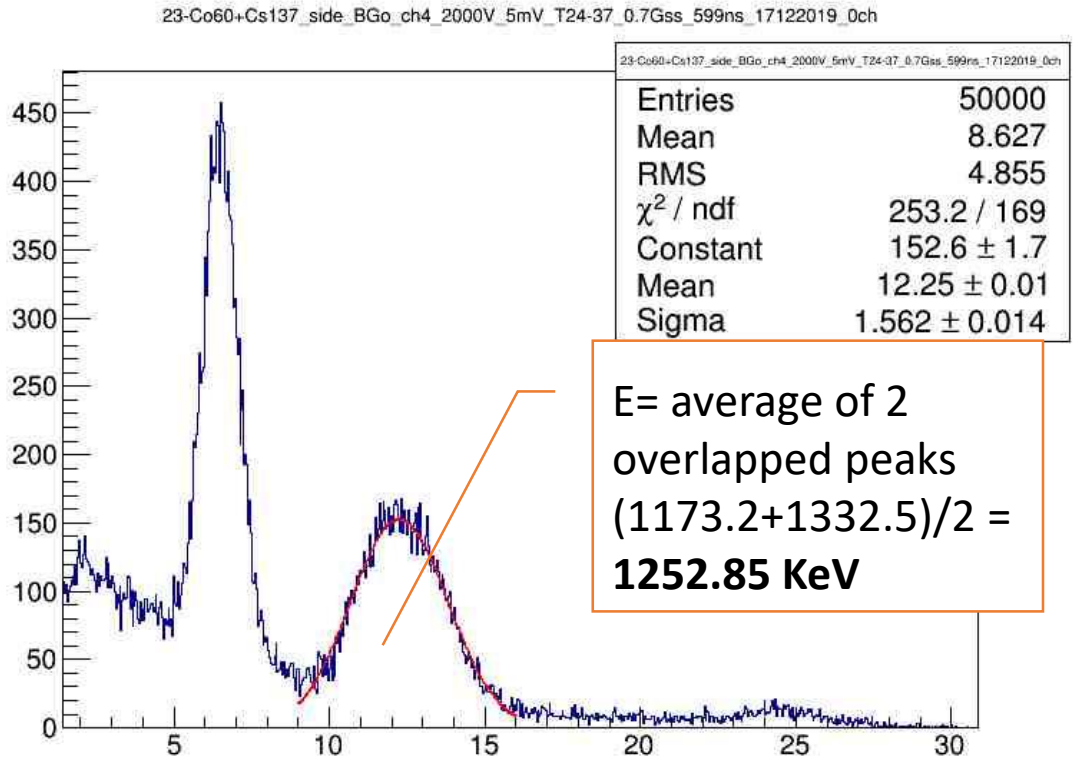
No.	Mean	Sigma	Applied voltage	RESOLUTION (%)
1	26.57	0.6234	900	5.5137
2	45.46	0.9904	1000	5.119754
3	73.25	1.577	1100	5.059317
4	108.5	1.968	1200	4.262488
5	148.8	2.499	1300	3.946673



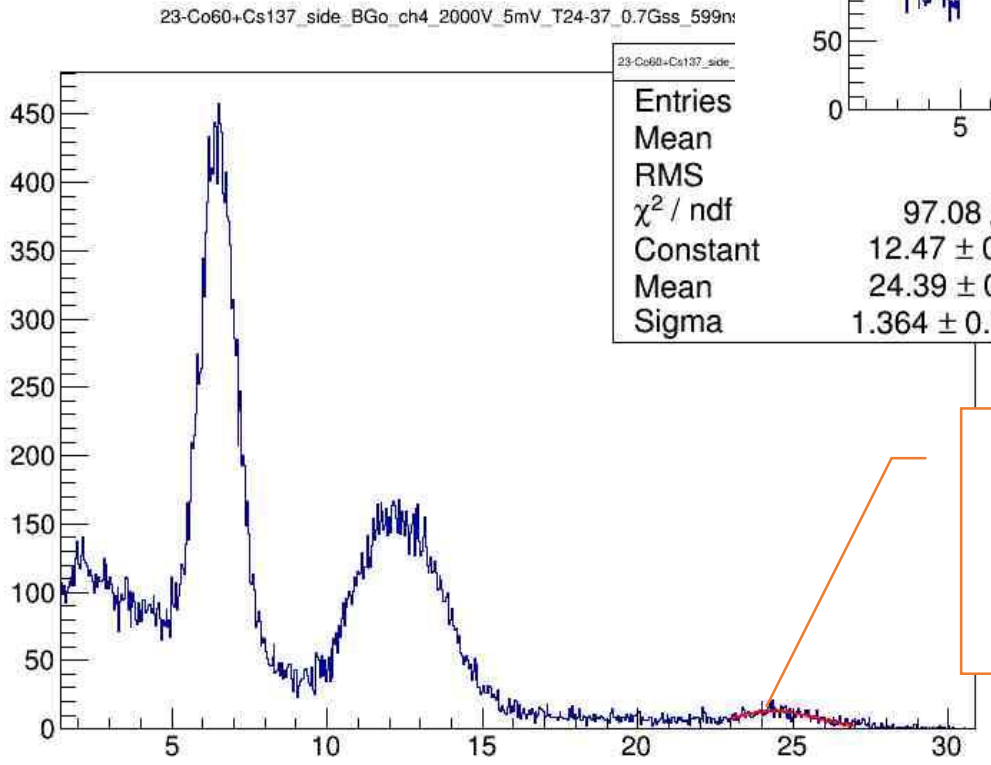
Calibration Curve for BGO detector



E= **662 KeV**



E= average of 2 overlapped peaks (1173.2+1332.5)/2 = **1252.85 KeV**



E= sum of 1173.2+1332.5 = **2505.7 KeV**

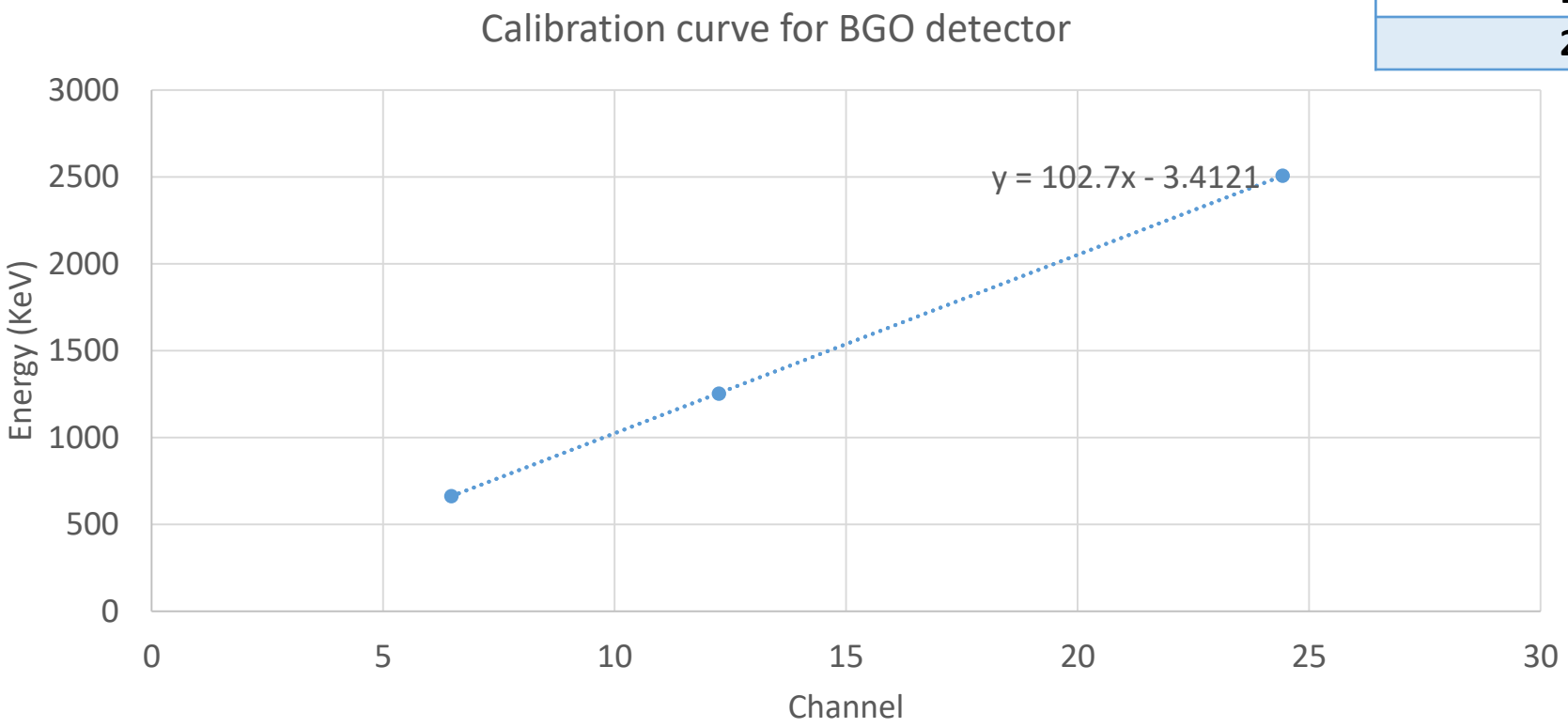
Calibration Curve for BGO detector:

$$Y = 102.7X - 3.4121$$

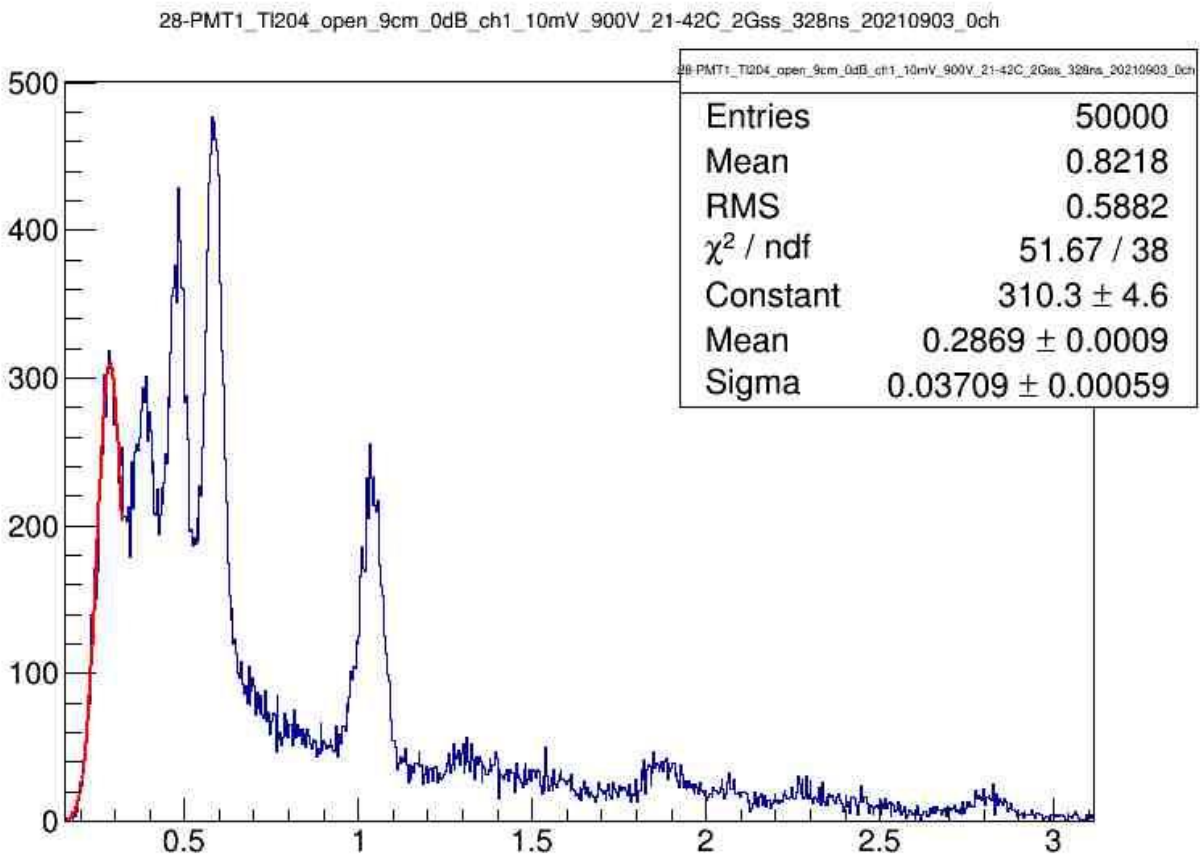
Where Y is the Energy in KeV and X is the channel number or the mean value.

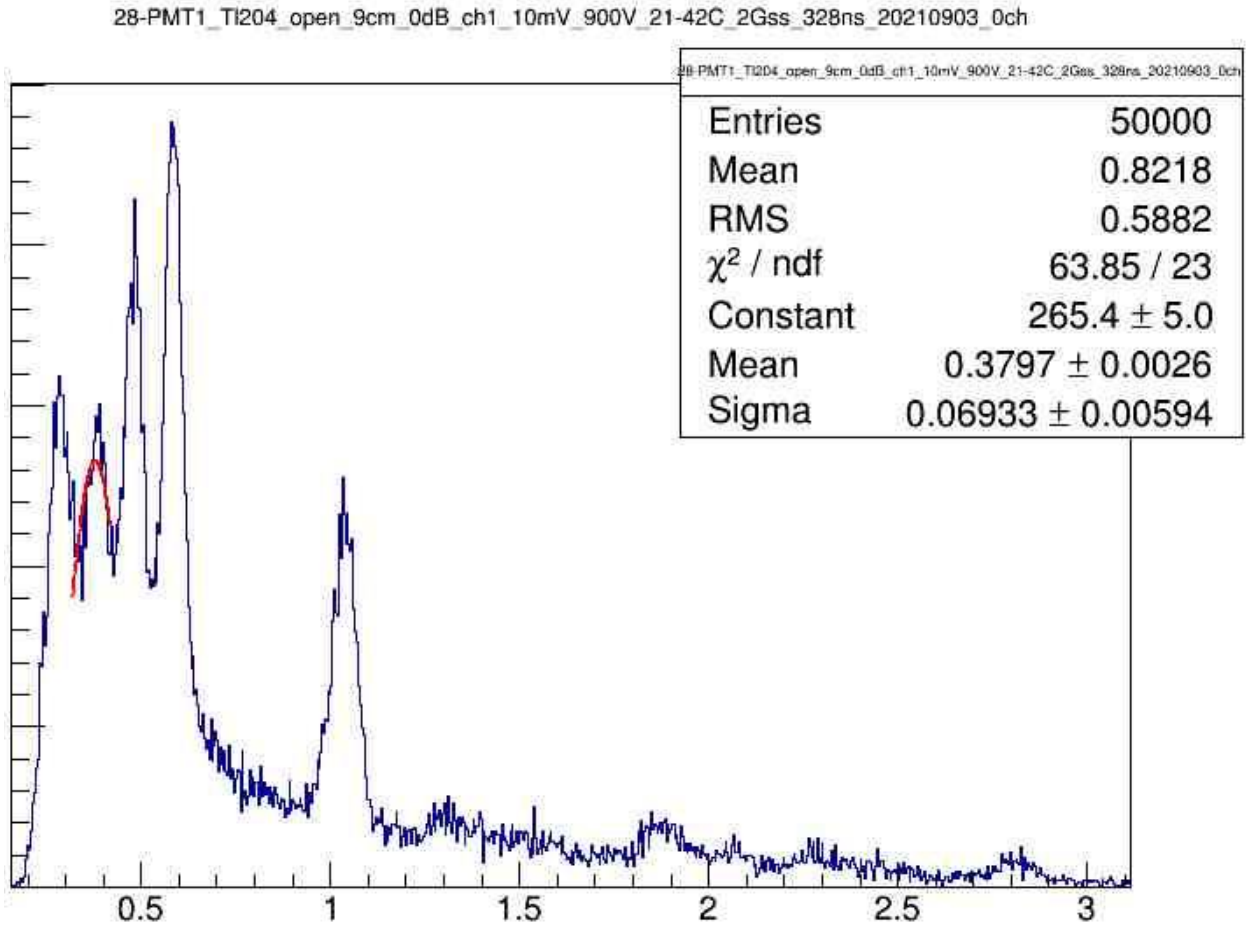
To identify unknown sources of radiation, we can do it by knowing the mean value of the peak and substituting in the equation above to get the energy and identify the isotope using the libraries known.

channel	Energy (KeV)
6.4685	662
12.2481	1252.85
24.4264	2505.7



Identifying the unknown isotopes using the calibration curve of BGO:





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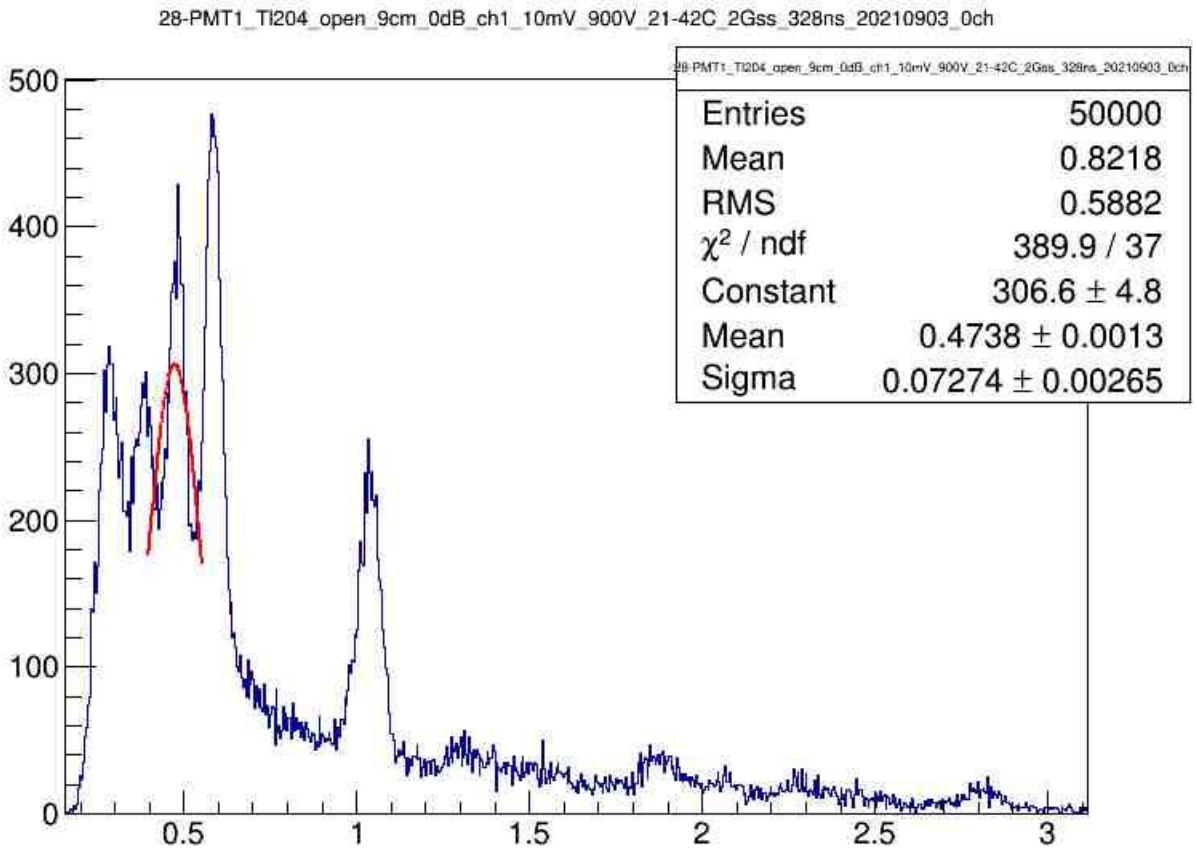
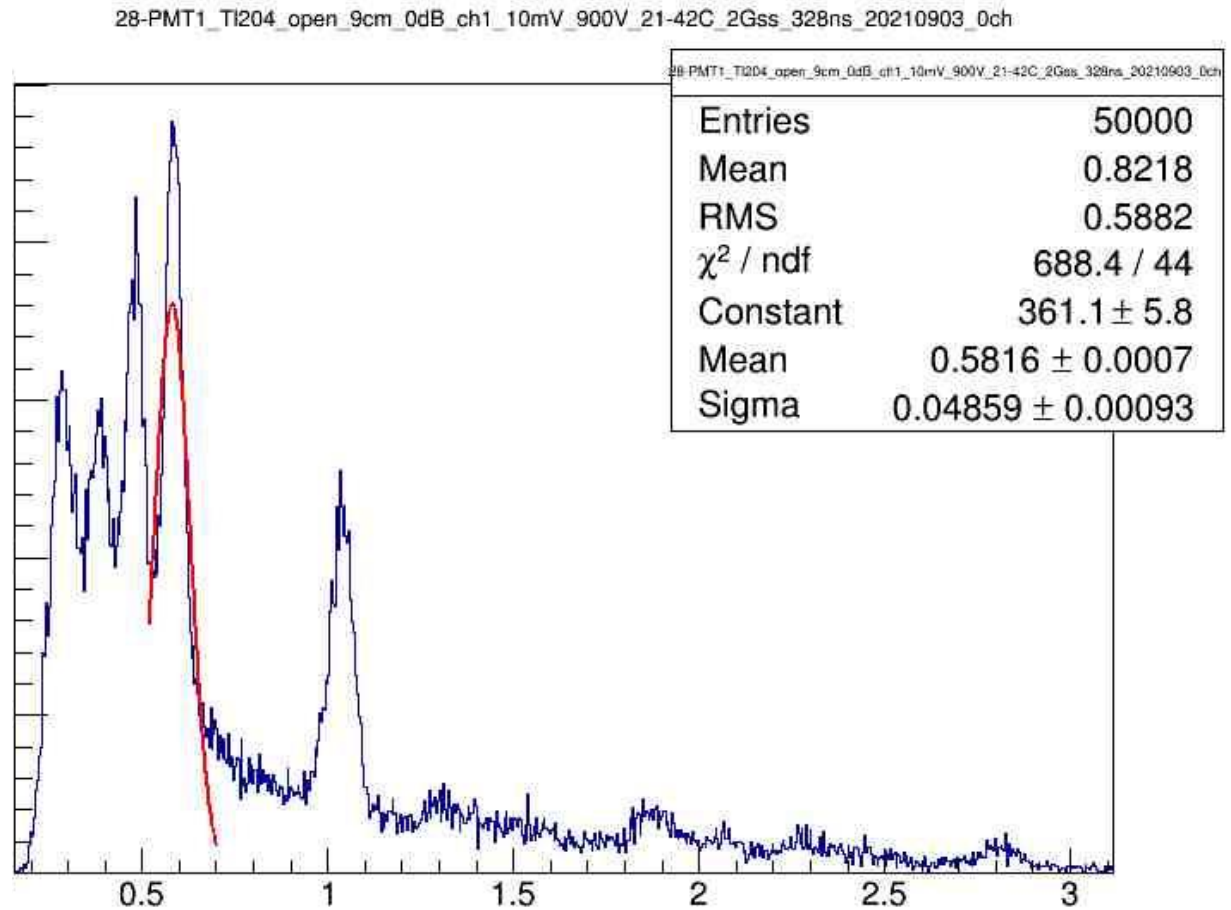
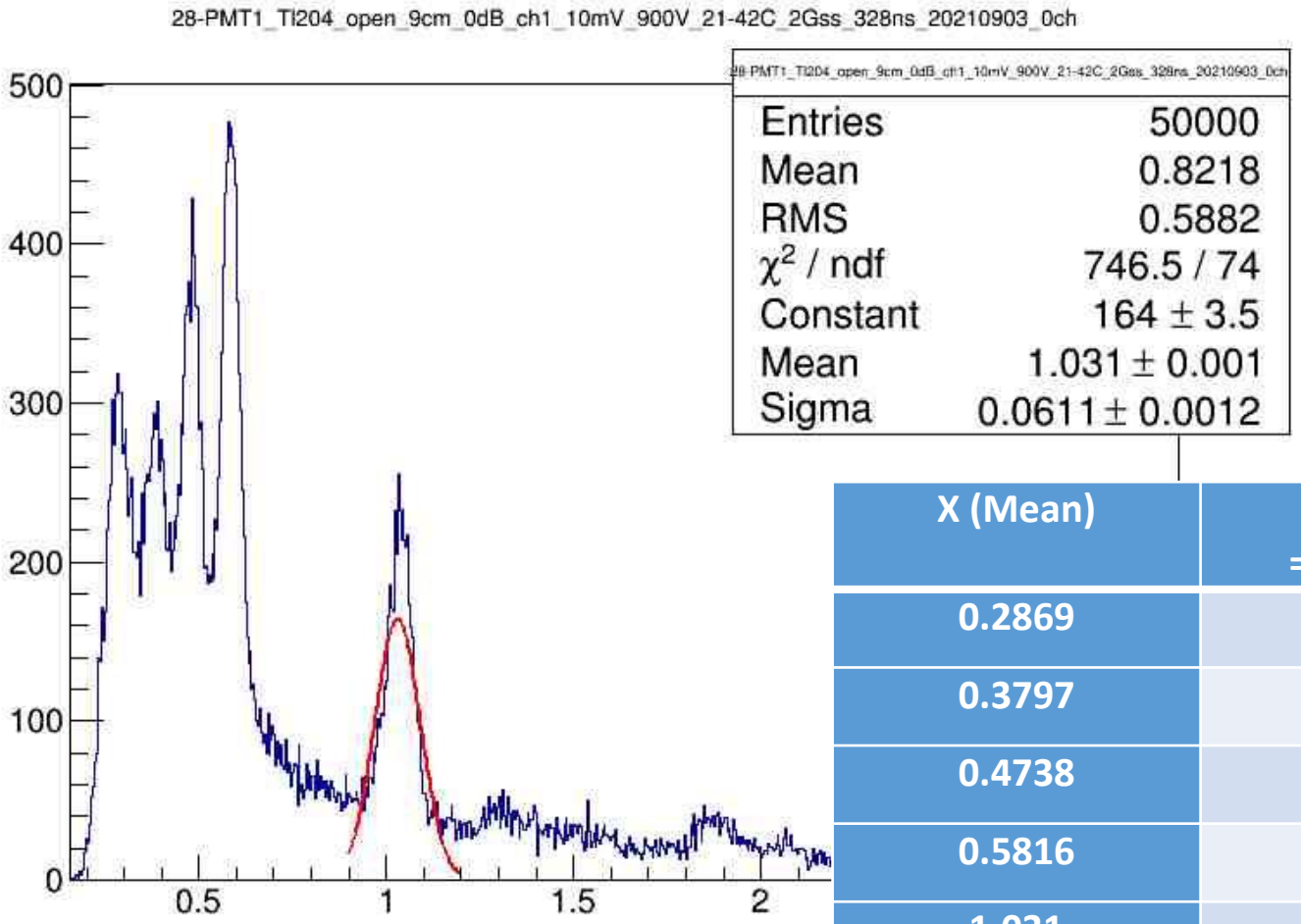


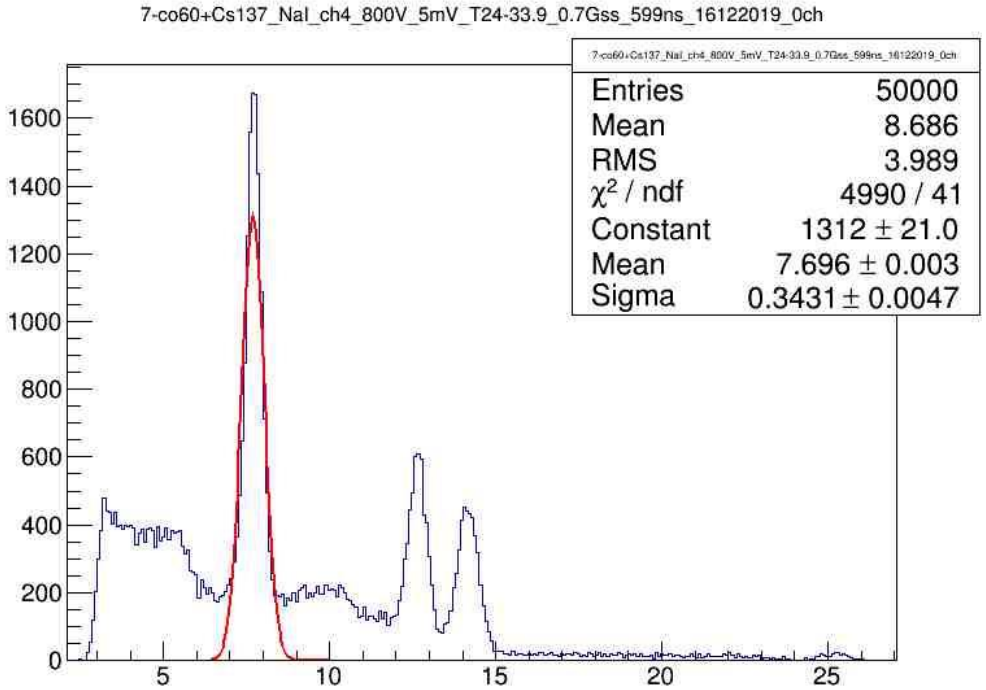


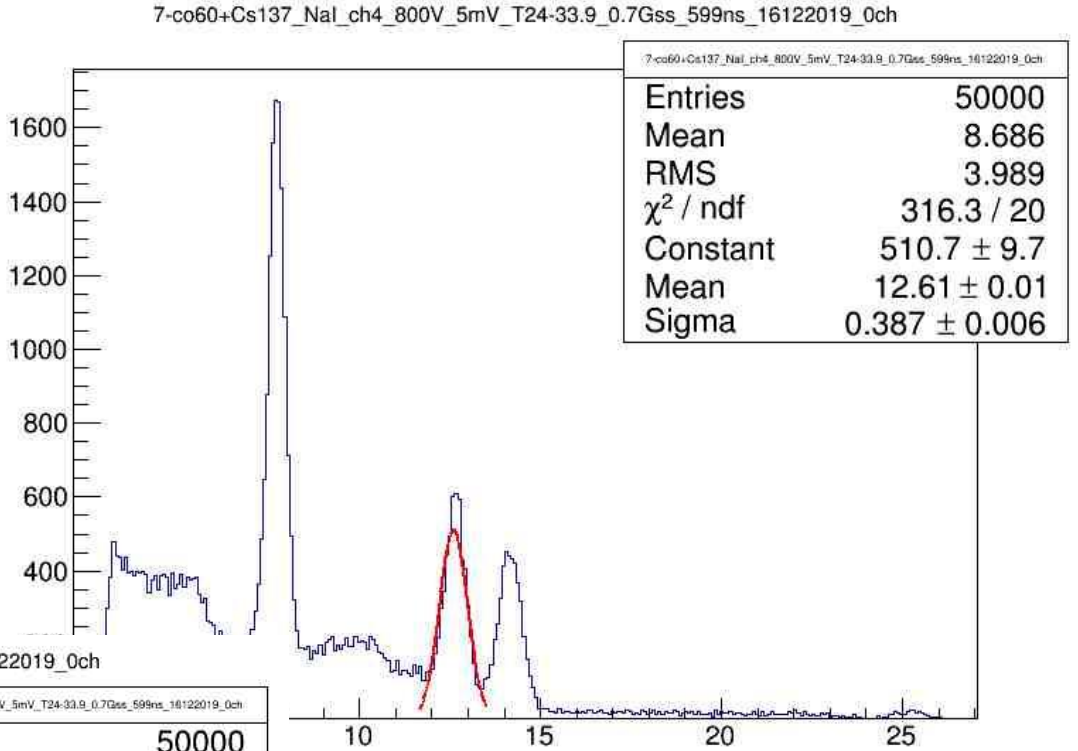
Identifying the unknown isotopes using the calibration curve of BGO:

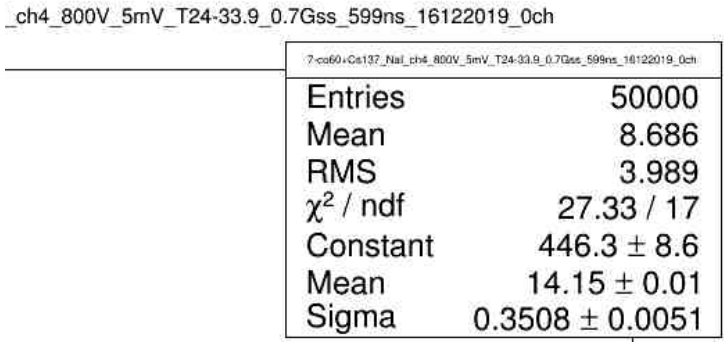


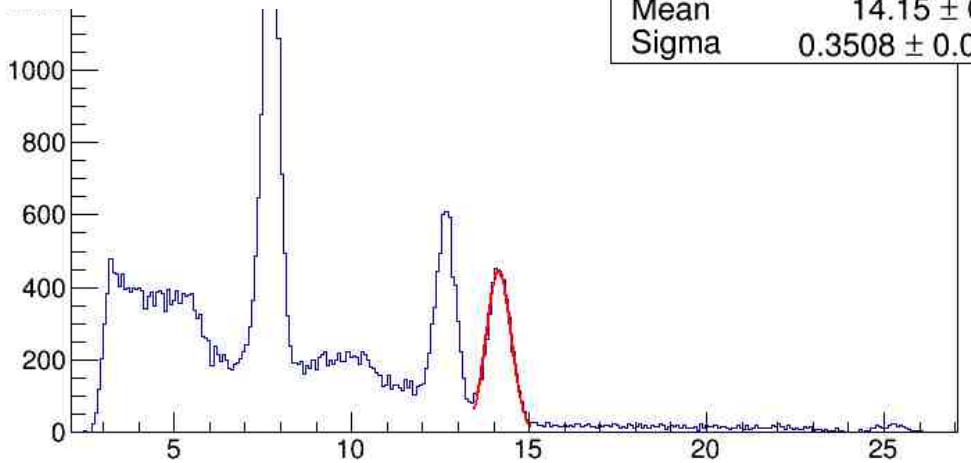
X (Mean)	Y [Energy (KeV)] =102.7*Mean-3.4121	Peak ID
0.2869	26.05253	Ba-140
0.3797	35.58309	I-125
0.4738	45.24716	Pb-210
0.5816	56.31822	Dy-259
1.031	102.4716	Sm-153
2.8	284.1479	I-131

Calibration Curve for NaI detector:







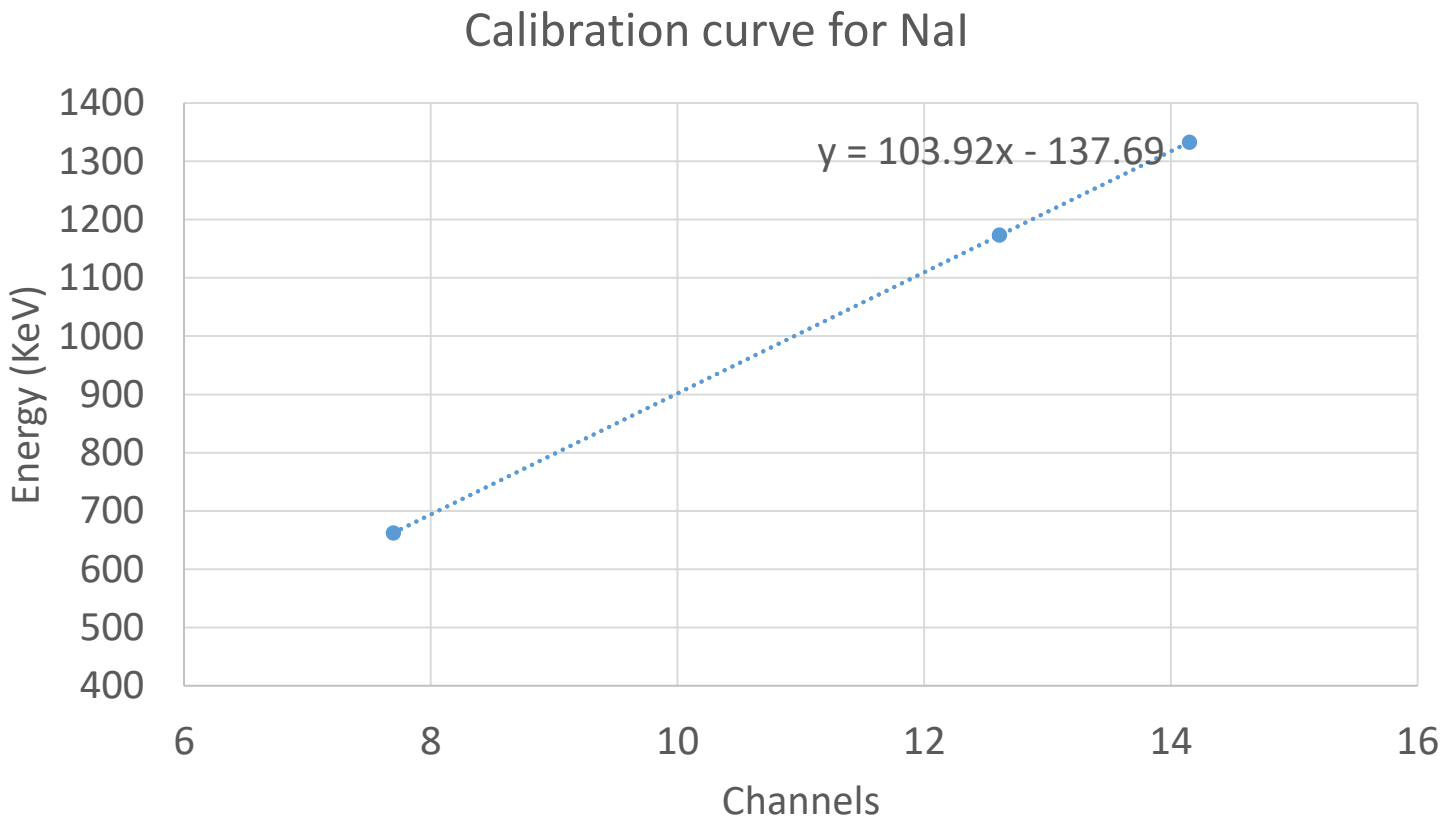


Calibration Curve for NaI detector:

$$y = 103.92\,x - 137.69$$

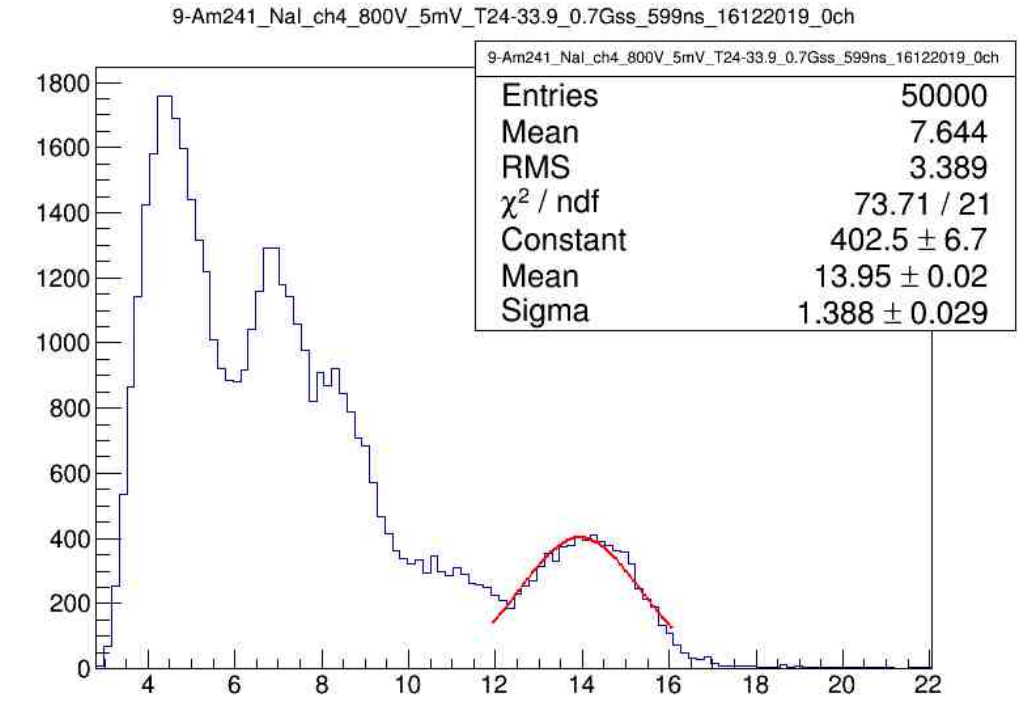
Where Y is the Energy in KeV and X is the channel number or the mean value.

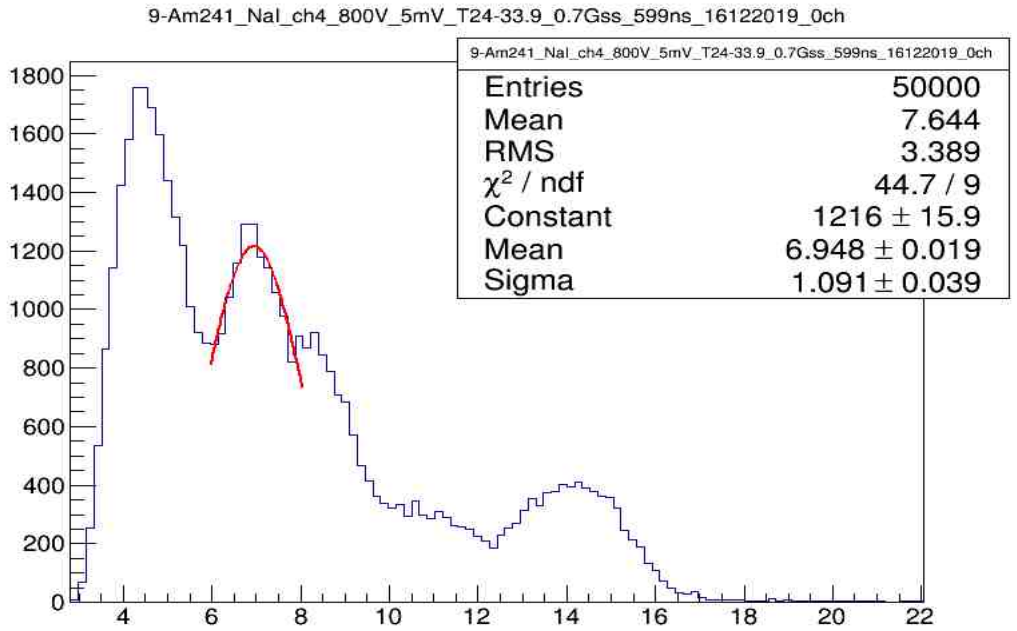
channel	Energy (KeV)
7.696	662
12.61	1173.2
14.15	1332.5

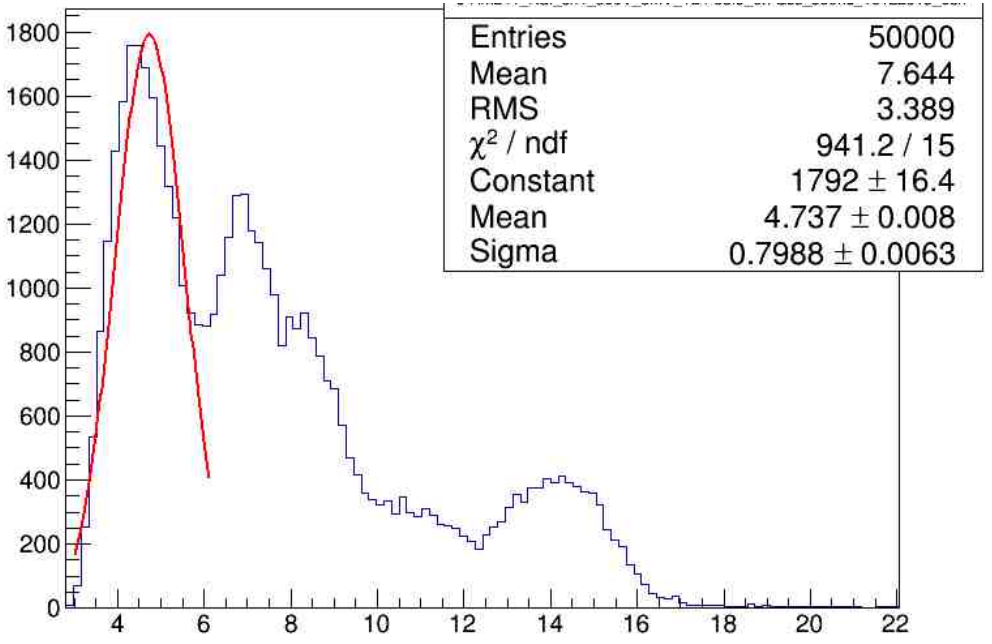


Identifying unknown source in NaI Detector:

Channel	Energy (KeV)	Peak ID
4.737	354.57904	Pb-214
6.948	584.34616	Ti-208
13.95	1311.994	Ca-47







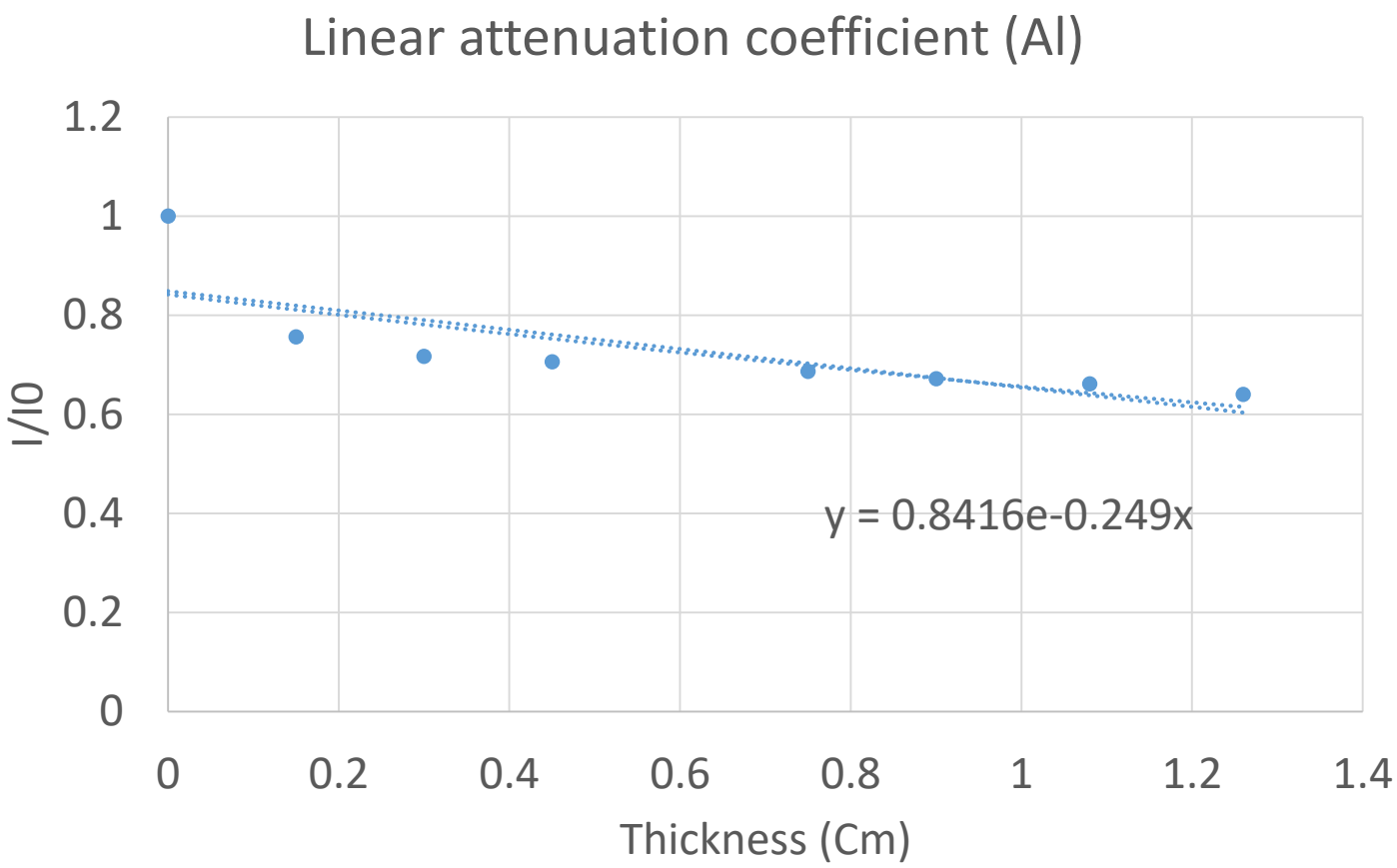
Attenuation coefficient:

$$I = I_0 e^{-\mu x}$$

$$\frac{I}{I_0} = e^{-\mu x}$$

Attenuation coefficient for Aluminum:

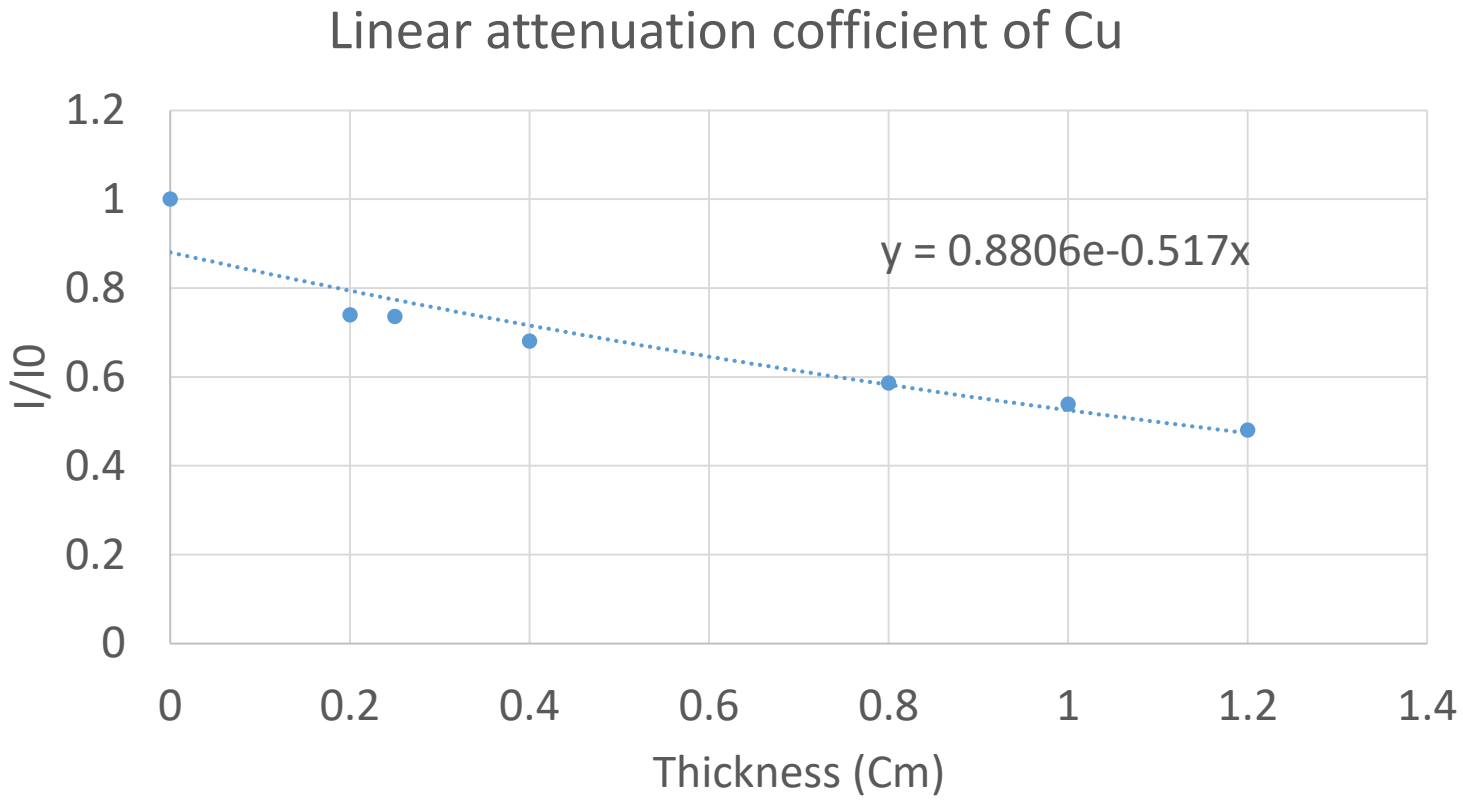
Thikness (cm)	I/I0
0	1
0.15	0.75573
0.3	0.71623
0.45	0.70569
0.75	0.68596
0.9	0.67155
1.08	0.66103
1.26	0.63939



$$\mu = 0.249\ Cm^{-1}$$

Attenuation coefficient for Copper:

Thickness (cm)	I/I0
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



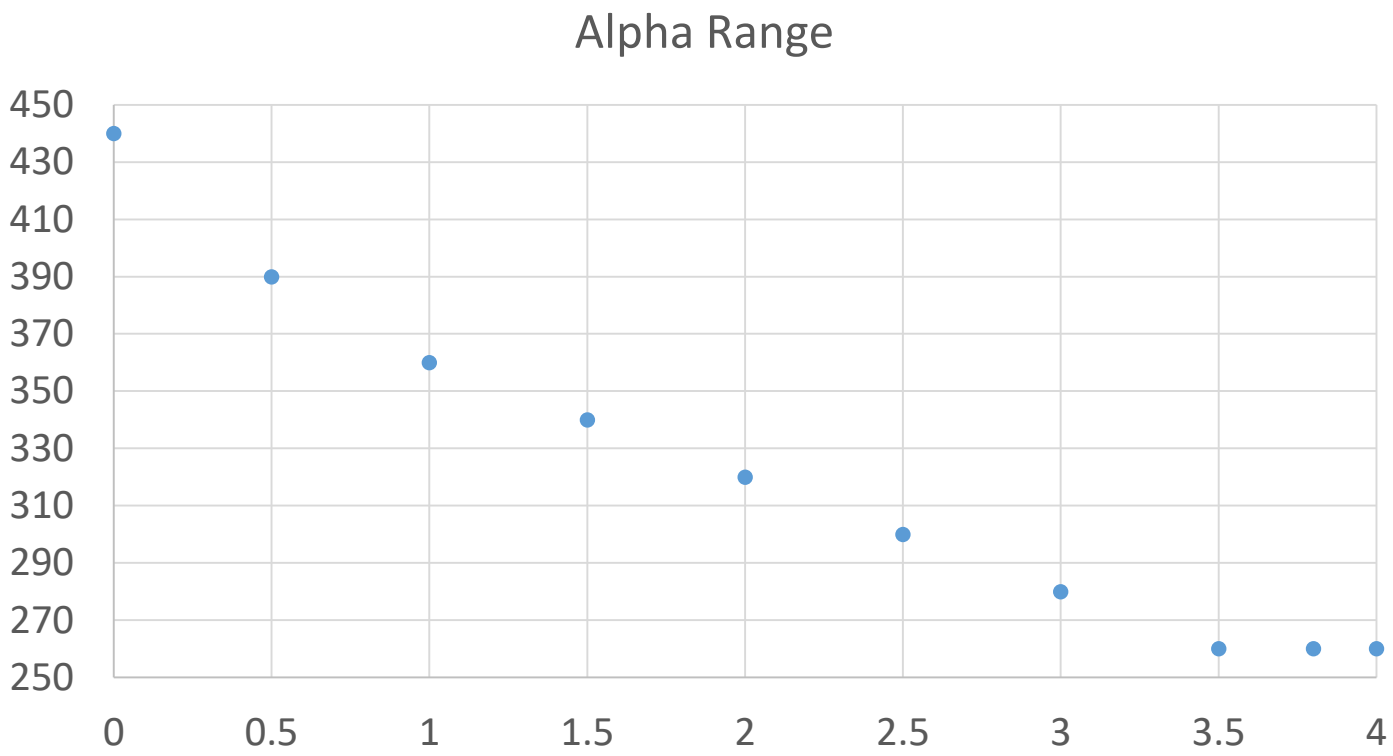
$$\mu = 0.517 \sim 0.52\ Cm^{-1}$$

Alpha Range:

Source of Pu-239
Energy = 5.5 MeV

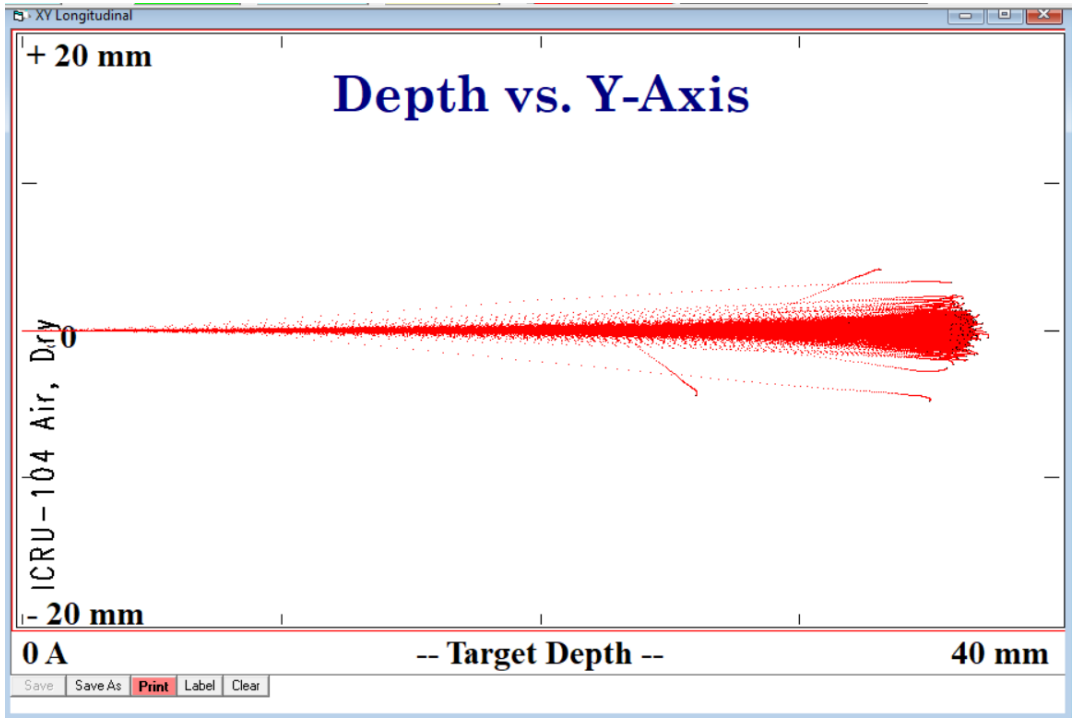
The range of alpha is 3.5 cm

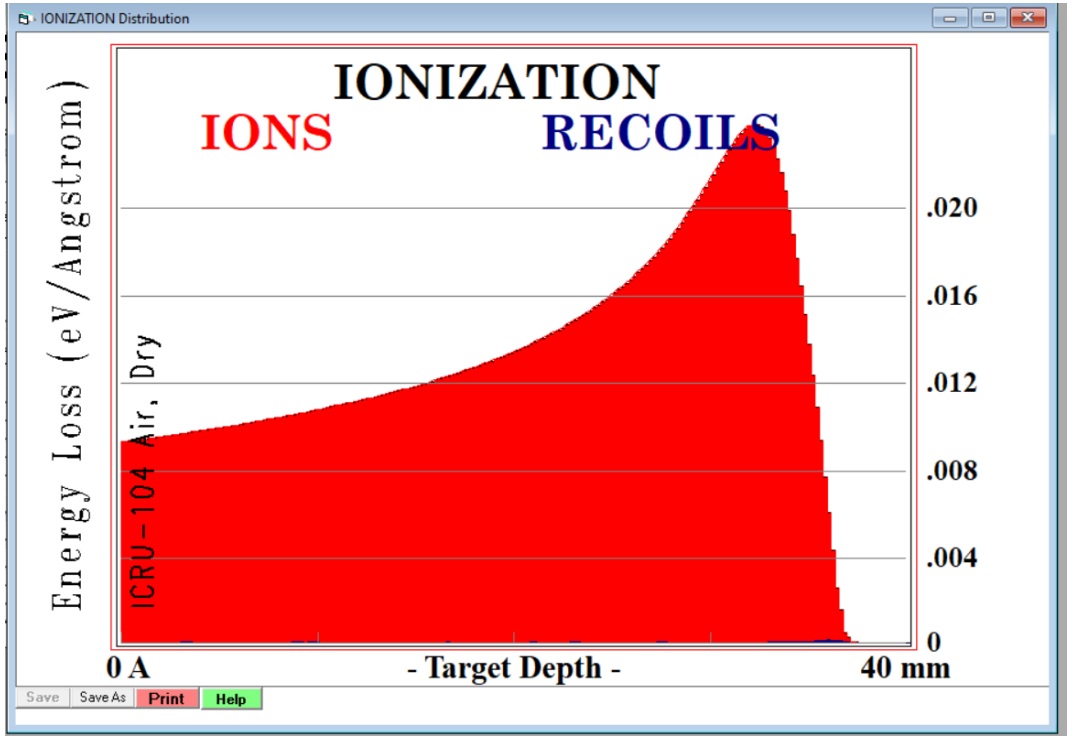
Distance (cm)	counts/ sec
0	440
0.5	390
1	360
1.5	340
2	320
2.5	300
3	280
3.5	260
3.8	260
4	260

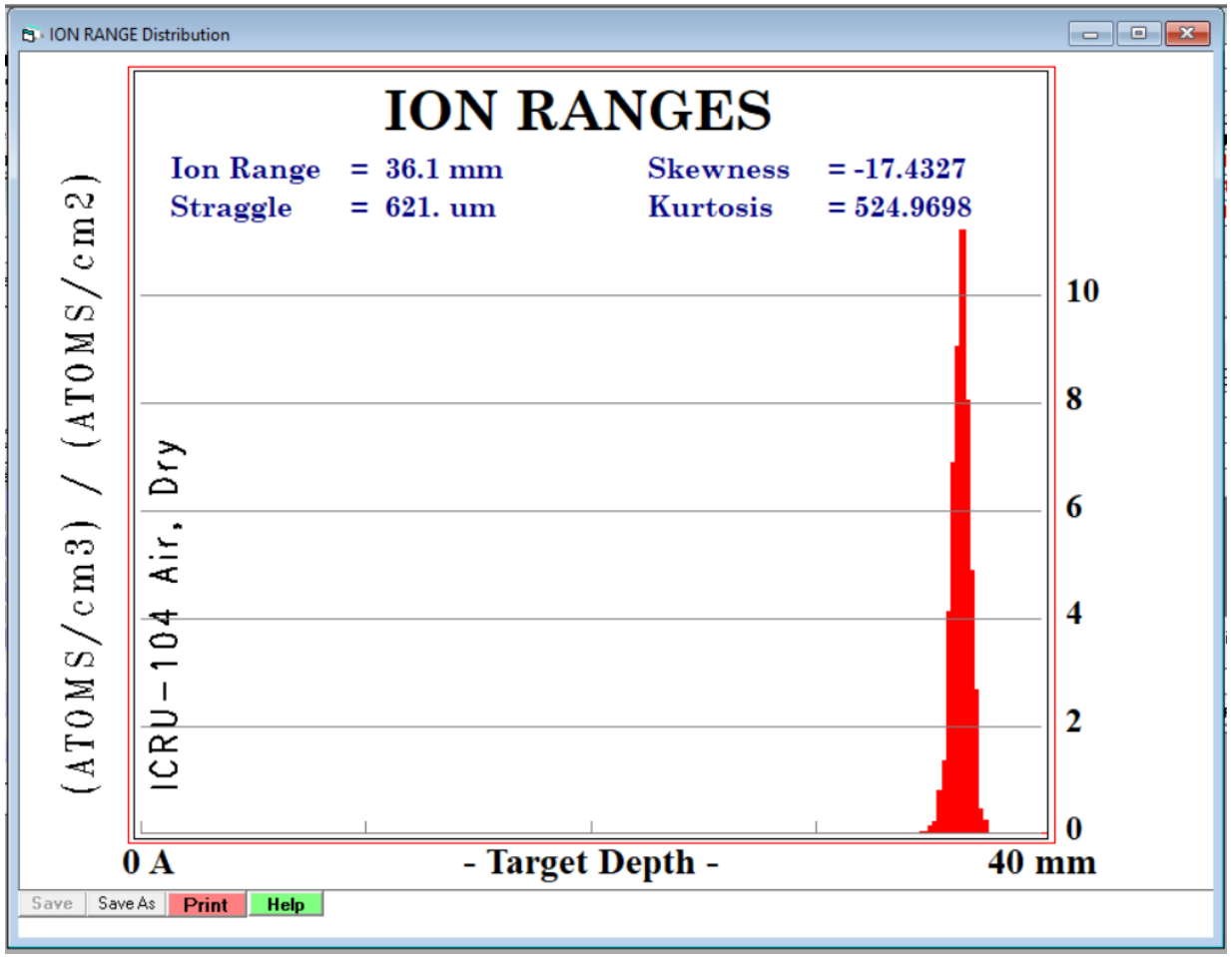


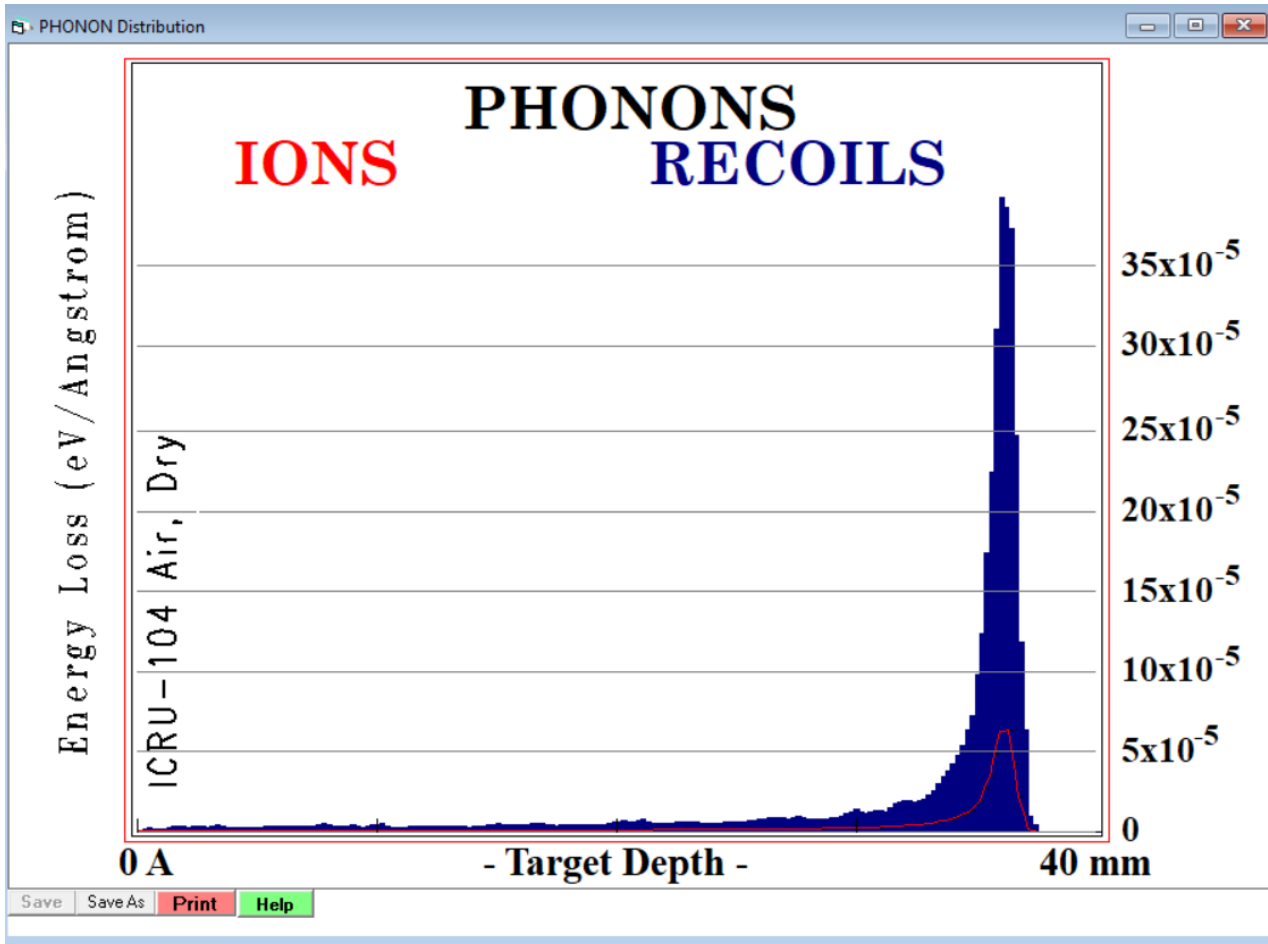
SRIM (Alpha stopping power) :

5 MeV Alpha is completely stopped at 3.61 cm deep in Dry air






ION RANGE Distribution
ION RANGES
Ion Range = 36.1 mm
Straggle = 621. um
Skewness = -17.4327
Kurtosis = 524.9698
(ATOMS/cm3) / (ATOMS/cm2)
ICRU-104 Air, Dry
10
8
6
4
2
0
0 A
- Target Depth -
40 mm
Save
Save As
Print
Help


PHONON Distribution
PHONONS
IONS
RECOILS
Energy Loss (eV/Angstrom)
ICRU-104 Air, Dry
35x10-5
30x10-5
25x10-5
20x10-5
15x10-5
10x10-5
5x10-5
0
0 A
- Target Depth -
40 mm
Save
Save As
Print
Help

Pixel detectors:

It consists of 2 parts: Sensor and Electronic chip

It has high resolution

Pixel size is $55\ \mu m\ *55\ \mu m$