Radiation Protection and the Safety of Radiation Sources

WAVE 7 (13June – 22 July)

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Scintillation Detectors:

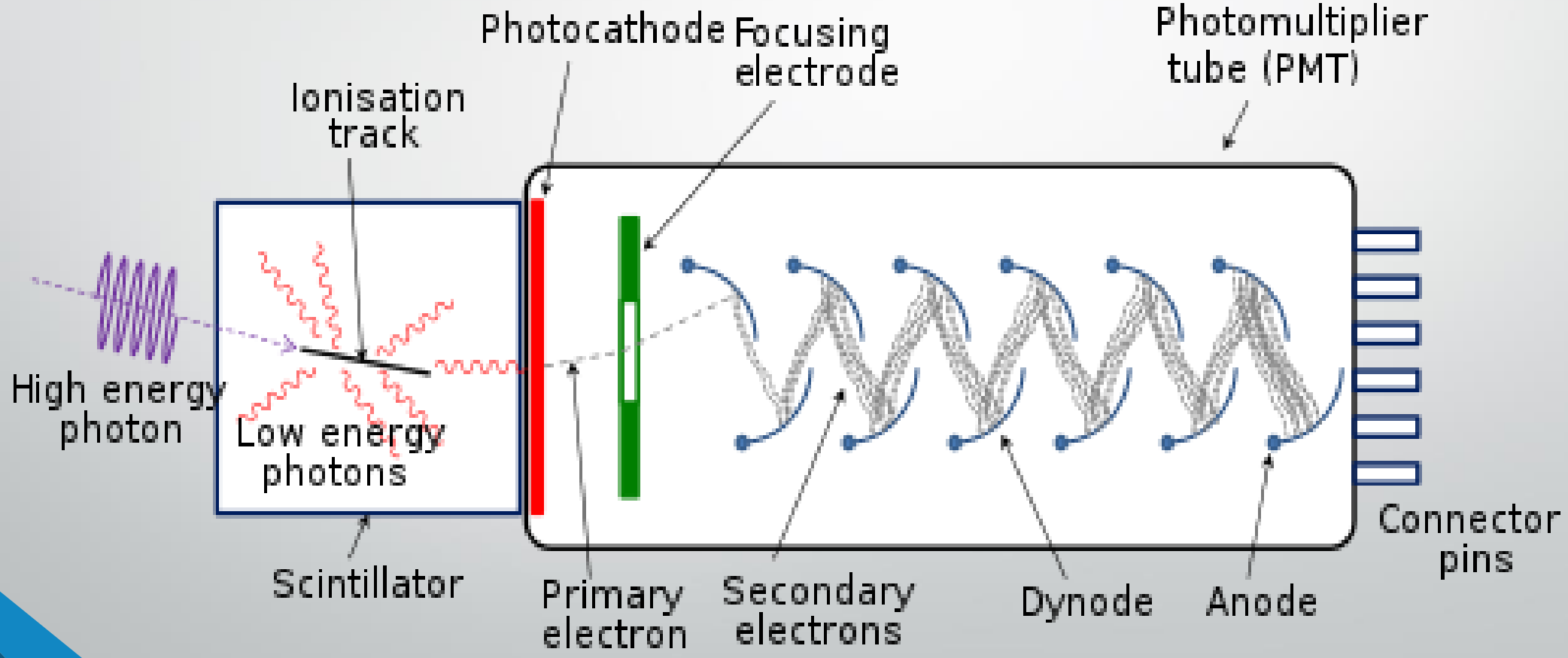
- **BGO – Bismuth Germanate ($Bi_4Ge_3O_{12}$)**
  - Highly effective gamma ray absorber;
  - Diverse applications: PET, HEP, NP, space and medical physics;
  - Crystals: 75 mm max diameters; 300 mm max lengths;
  - Wavelength range: 375-650 nm

- **NaI (Tl) – Sodium Iodide (Tl)**
  - A well established and the most extensively used scintillator;
  - Used for detection of gamma rays of low and intermediate energies;
  - Have an optical output well match to the maximum sensitivity of commonly available PMTs and it is independent of temperature;
  - Crystals: 150 mm max diameters; 400 mm max lengths;
  - Wavelength range: 325-550 nm

Scintillator properties of crystals:

Scintillator	Light output	Decay (ns)	Wavelength (nm) max	Density (g/cm2)	Hygroscopic
Na(Tl)	100	250	415	3.67	yes
CsI	5	16	315	4.51	slightly
BGO	20	300	480	7.13	no
BaF2(f/s)	3/16	0.7/630	220/310	4.88	slightly
CaF2	50	940	435	3.18	no
CdWO4	40	14000	475	7.9	no
LaBr3(Ce)	165	16	380	5.29	yes
LYSO	75	41	420	7.1	no
YAG(Ce)	15	70	550	4.57	no

Photomultipliers Tubes:



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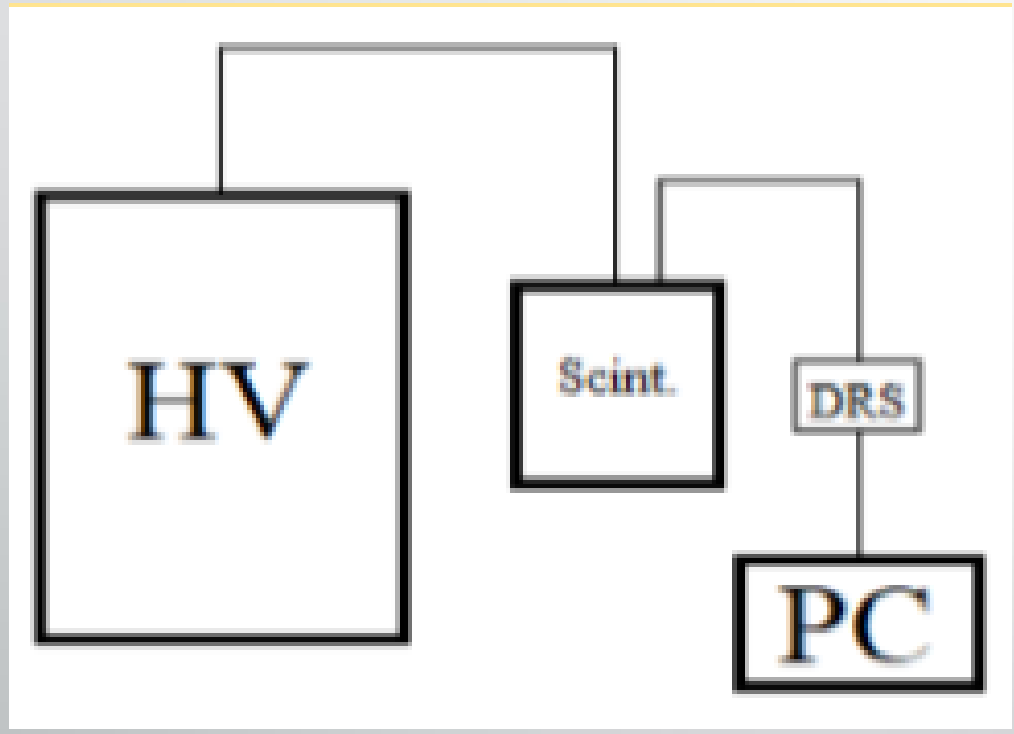
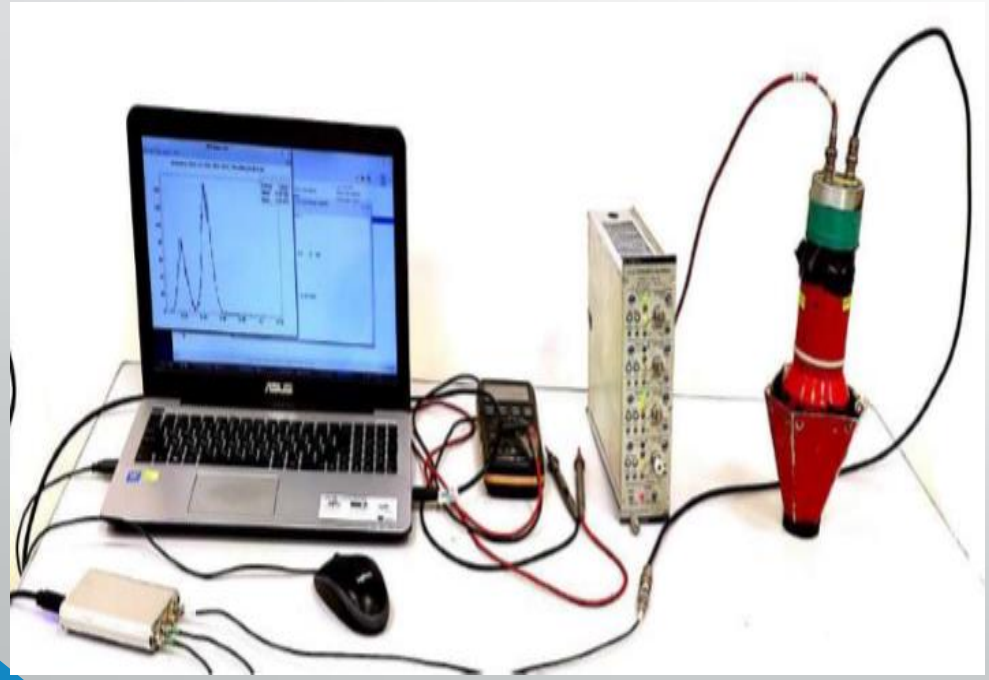


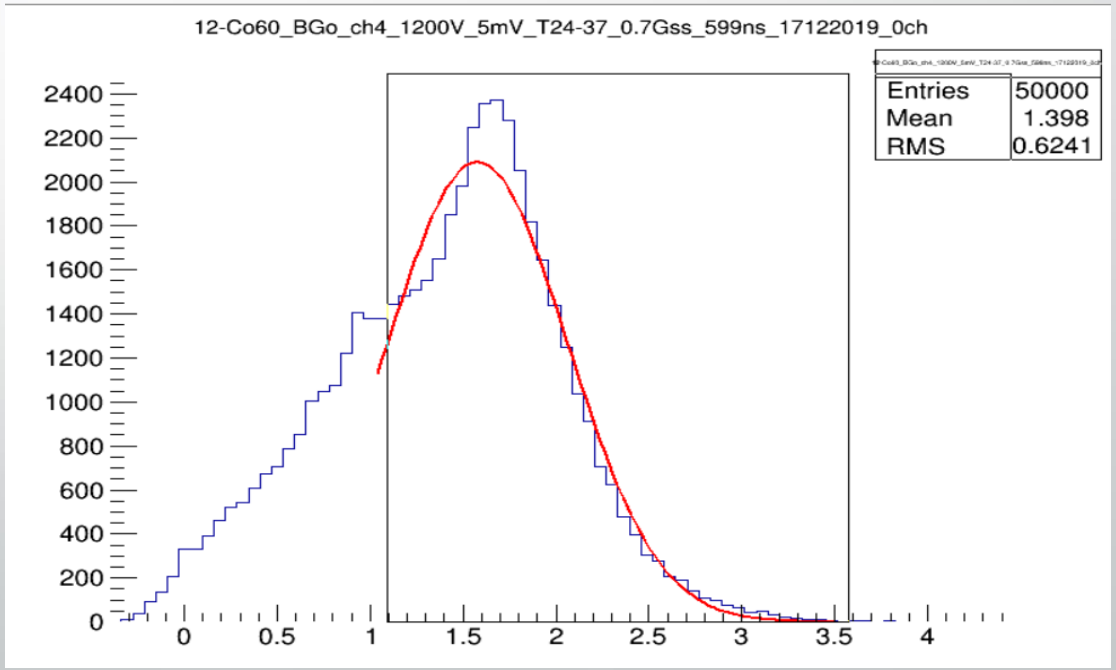
Scheme

System Setup

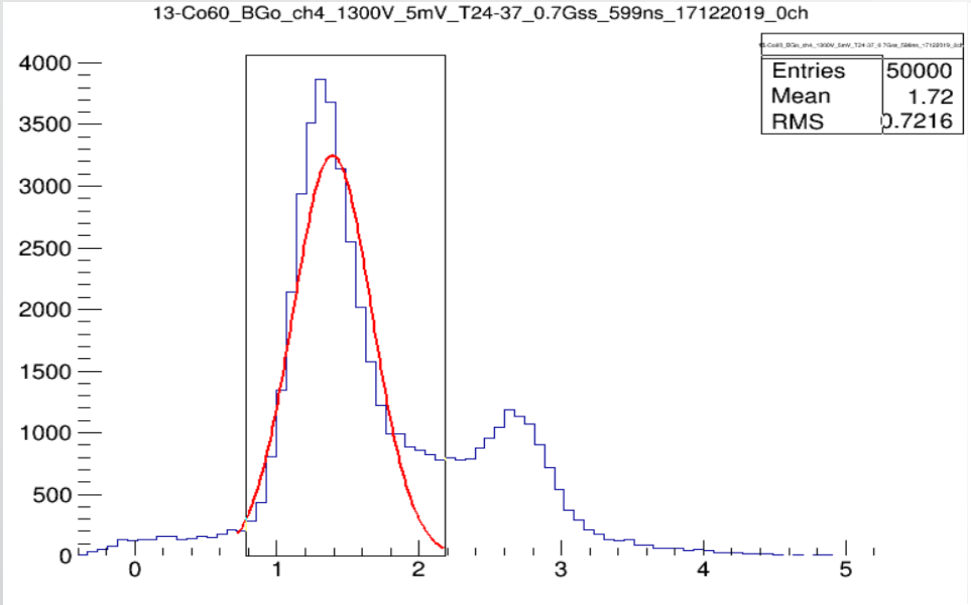
Task 1: The relation between Resolution and Applied Voltage.

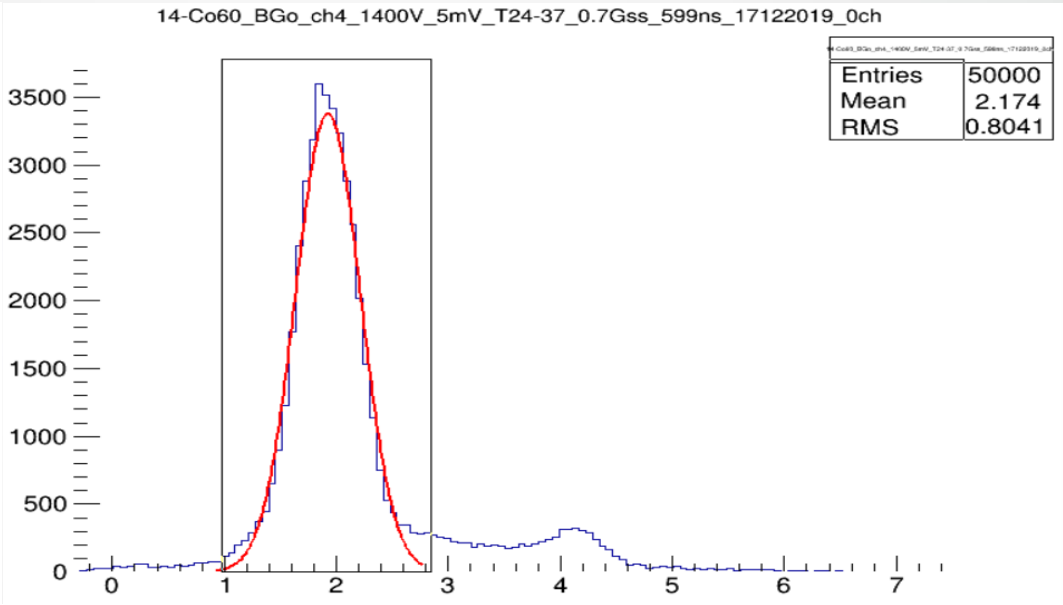
Using BGO scintillation detector and fitting data by root software and equation ***R =(Sigma/ Mean) X 2.35***

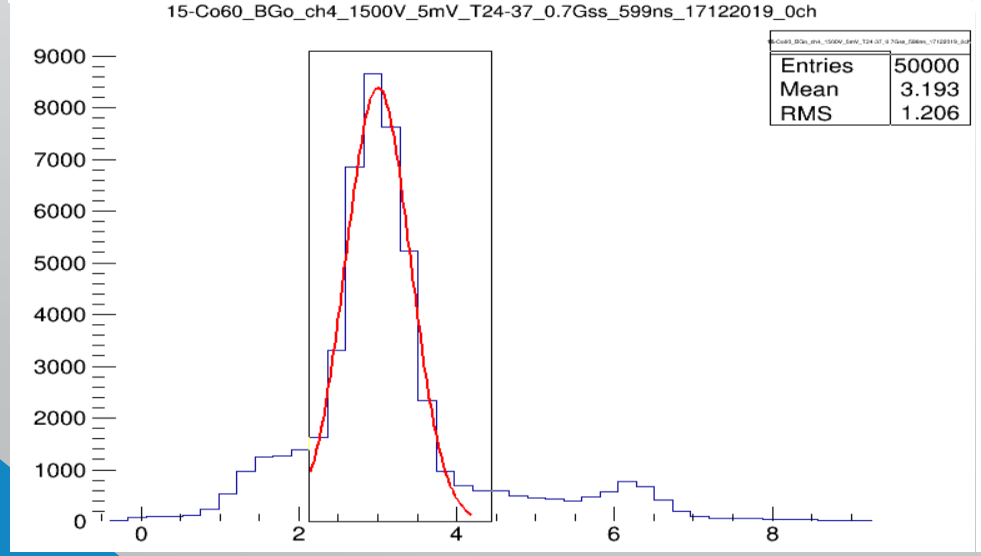


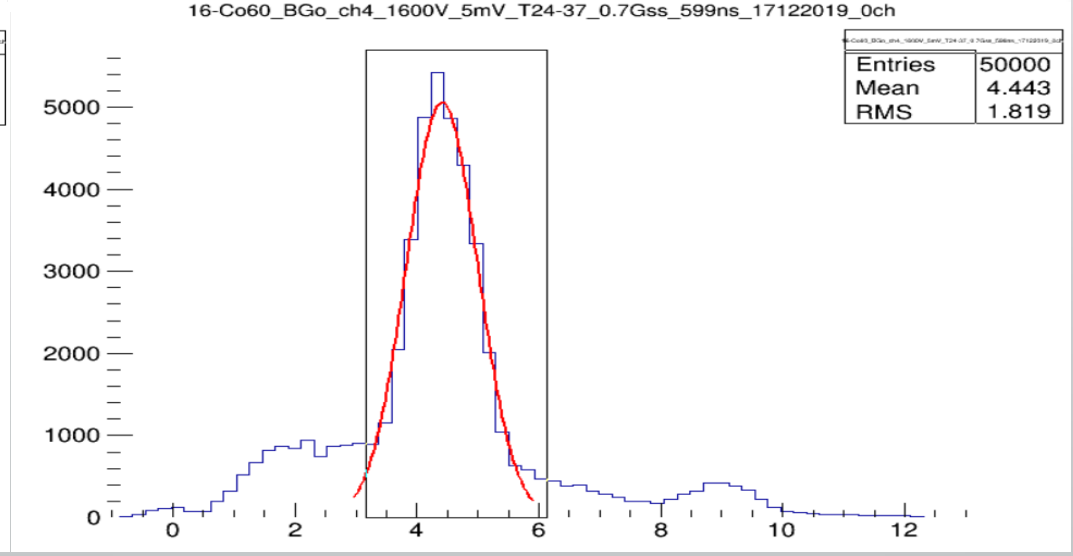


Task 1: The relation between Resolution and Applied Voltage.









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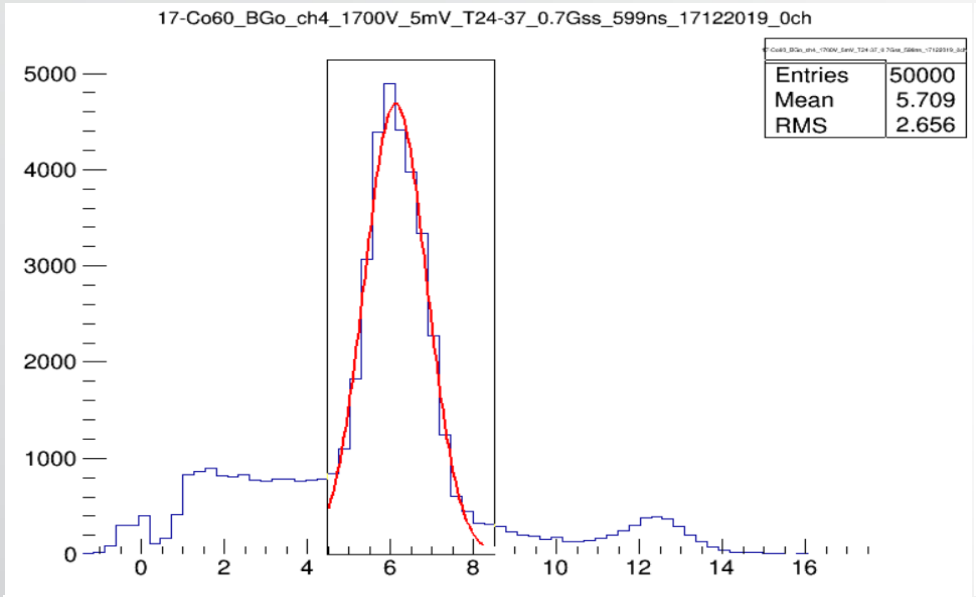
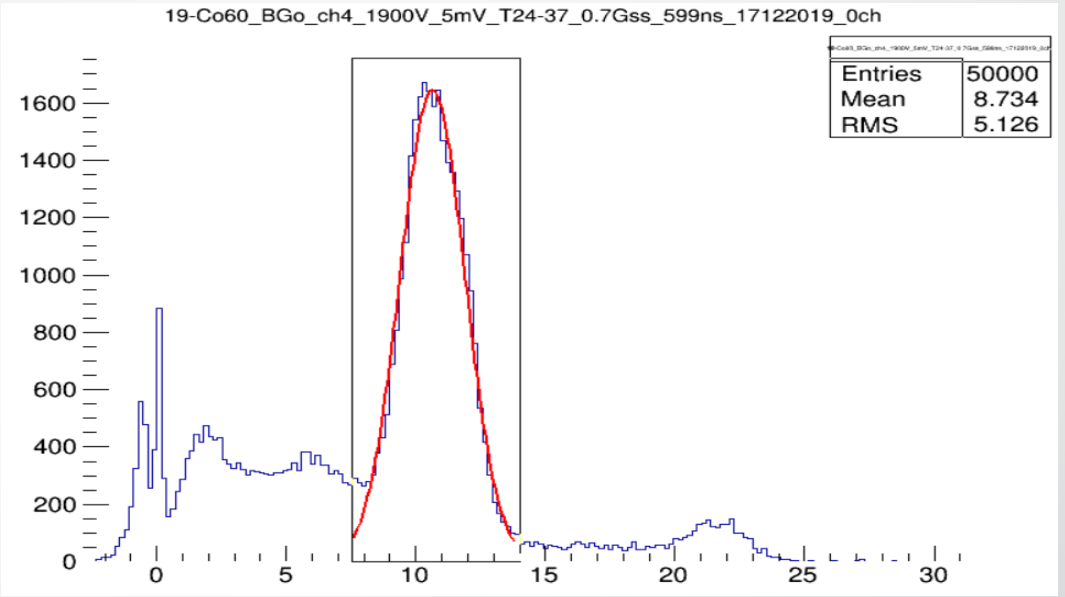
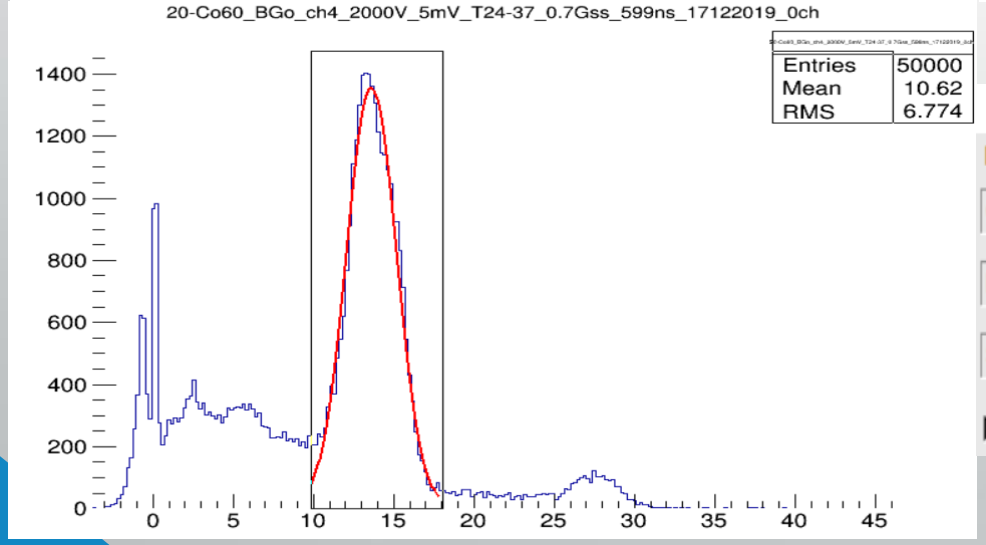
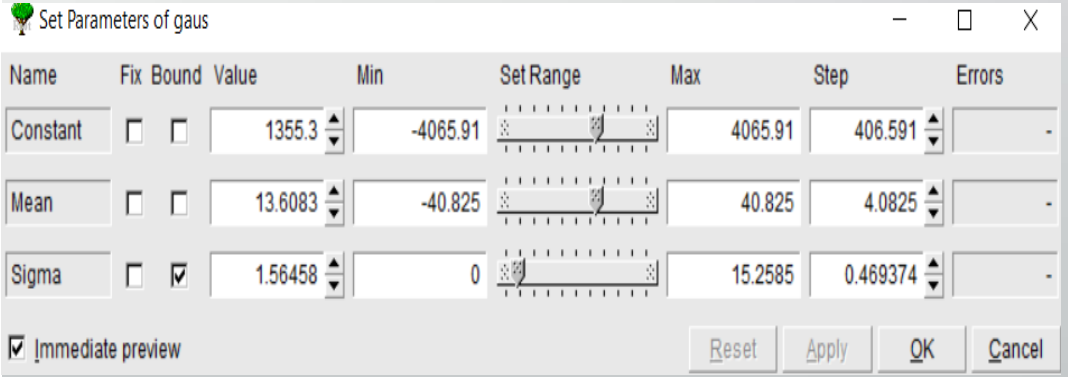


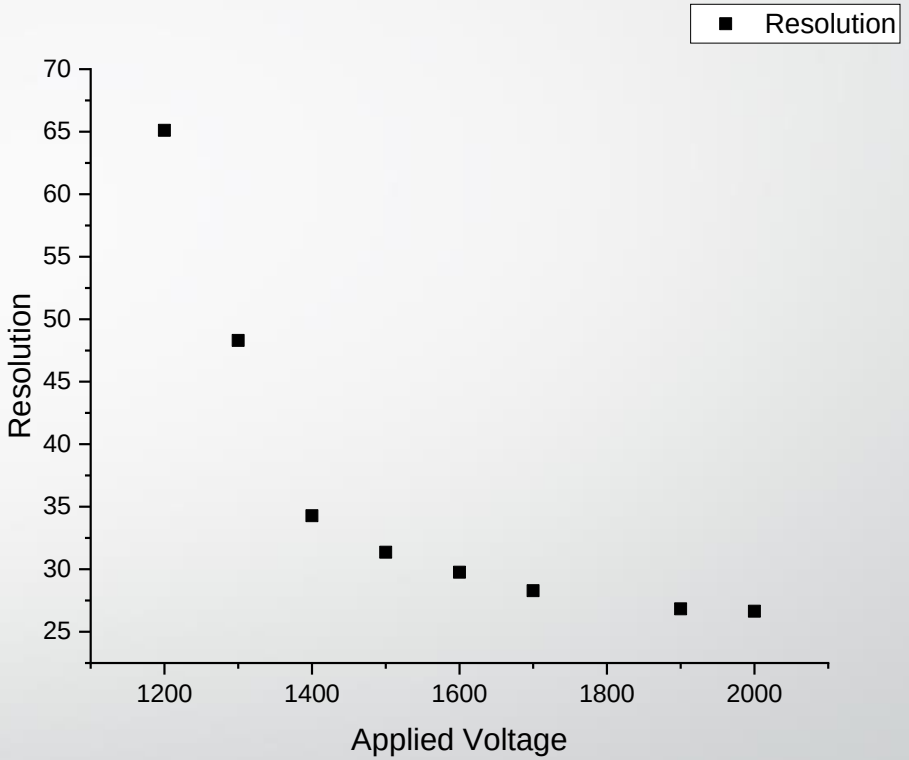




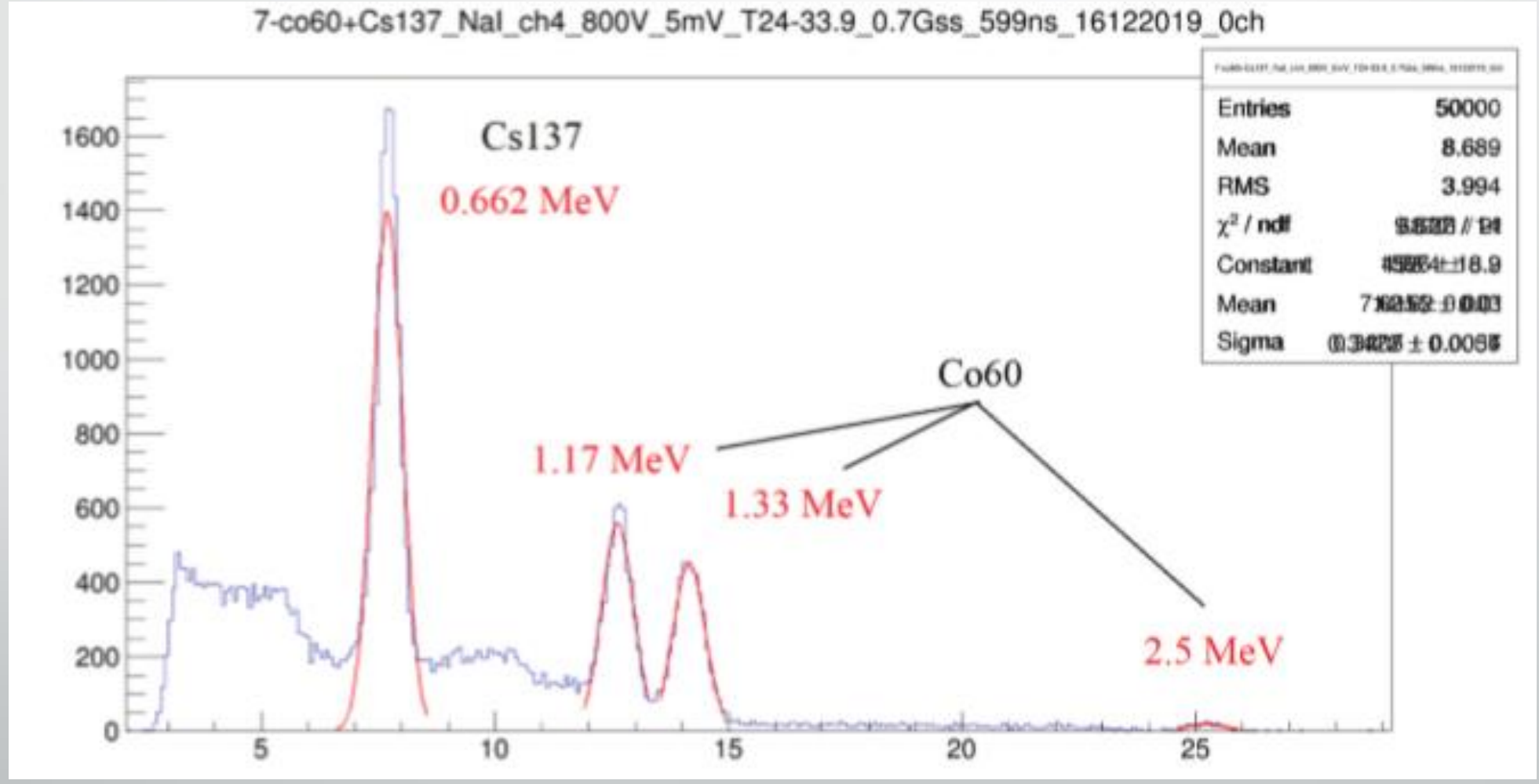


Task 1: The relation between Resolution and Applied Voltage.

Sigma	Mean	V	Resolution
0,448657	1,61954	1200	65,10144547
0,286926	1,39592	1300	48,30334833
0,279704	1,91731	1400	34,28263557
0,400444	3,00033	1500	31,36466322
0,559484	4,41796	1600	29,76005668
0,735224	6,11018	1700	28,27701312
1,21903	10,6802	1900	26,82272336
1,54554	13,6303	2000	26,64665488



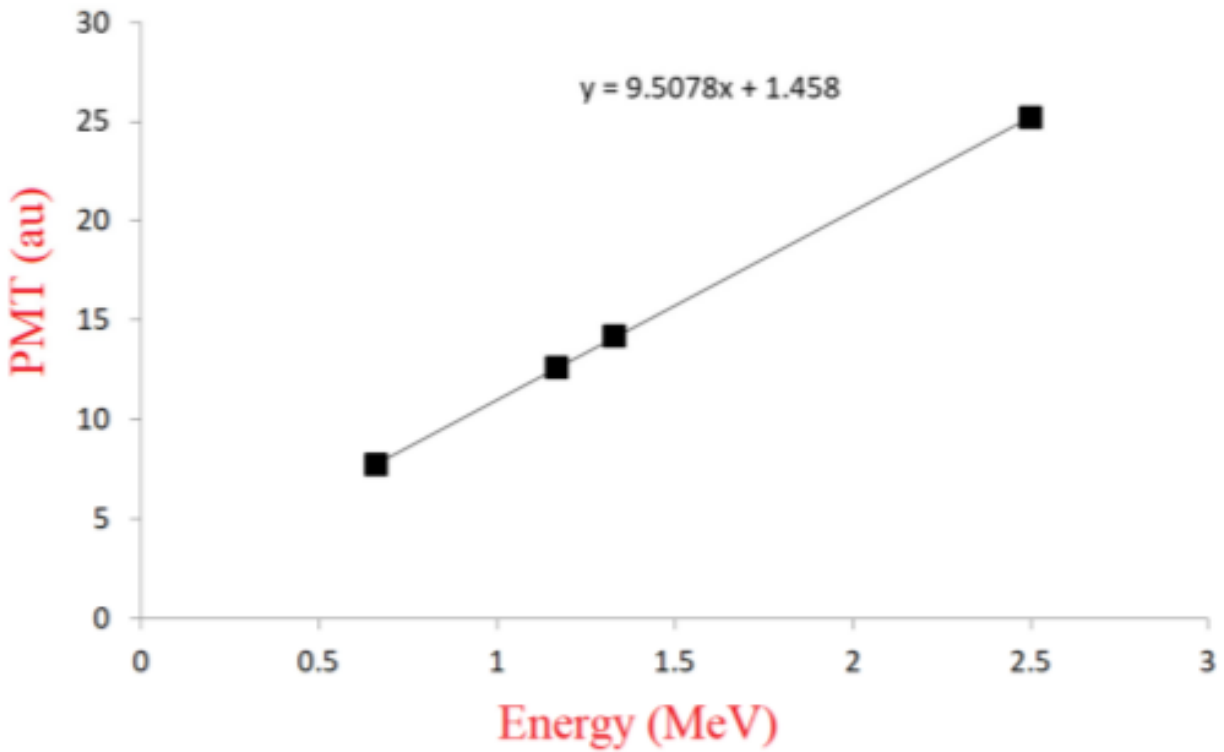
Task 2: Calibration For Nal Detector using Co60+Cs137 at 800 v



Gauss Fit

Task 2: Calibration

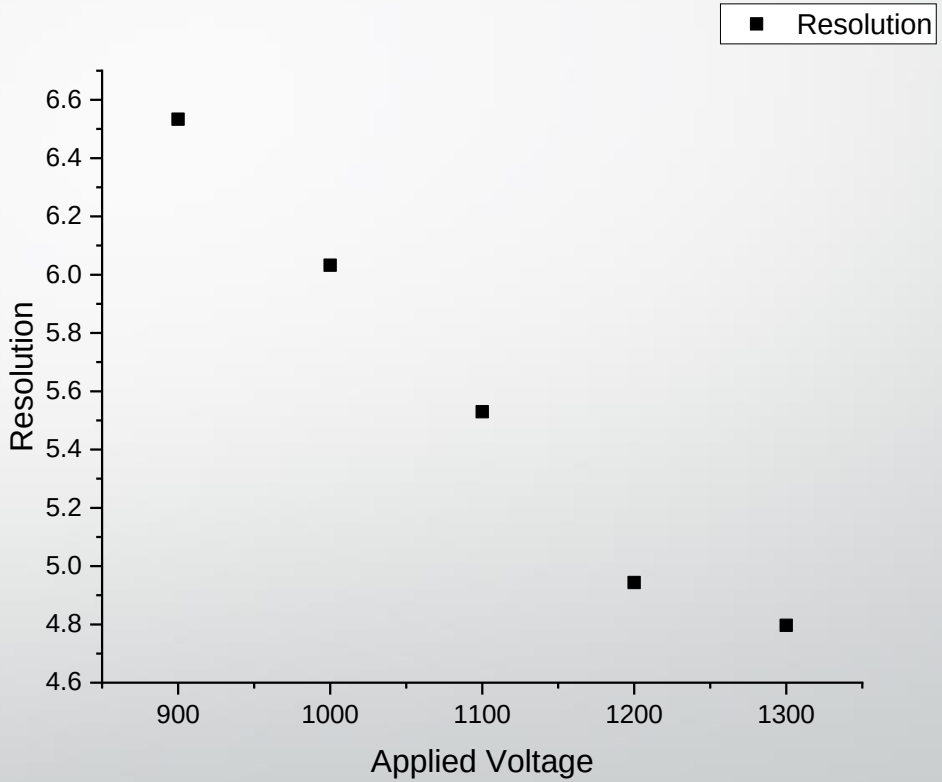
	A	B
1	Energy (MeV)	PMT (au)
2	0.662	7.695
3	1.17	12.62
4	1.33	14.15
5	2.5	25.2



Graph and Linier Fit

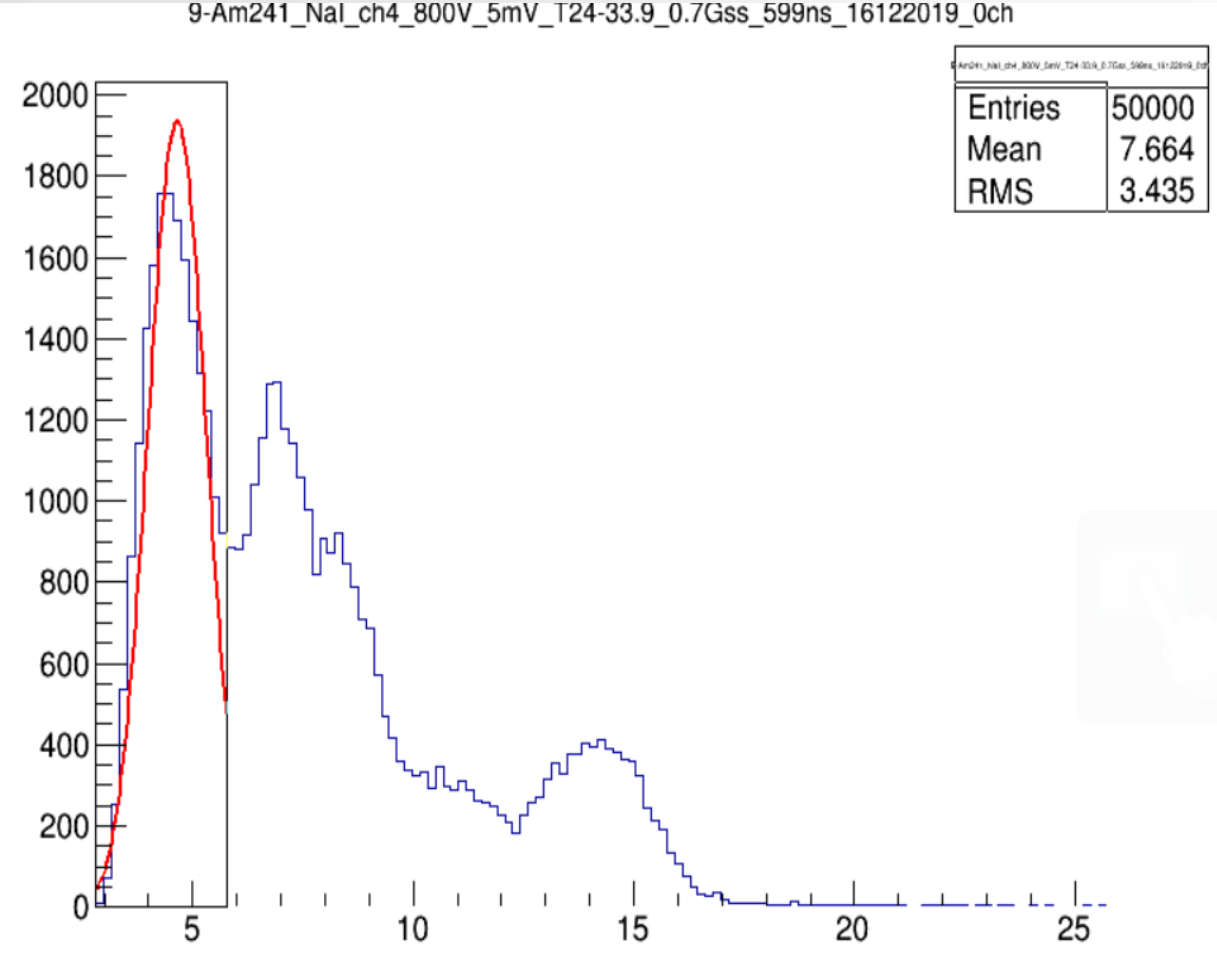
Task 2: Resolution and Applied Voltage for NaI Detector

Sigma2	Mean	R	V
0.66775	23.6737	6.53361	900
1.04255	40.6143	6.03234	1000
1.54727	65.7545	5.52979	1100
2.07692	98.727	4.9437	1200
2.63866	137.359	4.79652	1300



R =(Sigma/ Mean) X 2.35

Task 2: Unknown source using NaI detector with Cs137



Mean= Y= 4.55

Y= 9.5078X + 1.458
=> X= (Y-1.458)/9.5078
X= (4.55-1.458)/9.5078
X= 0.507

E= 0.325 Mev

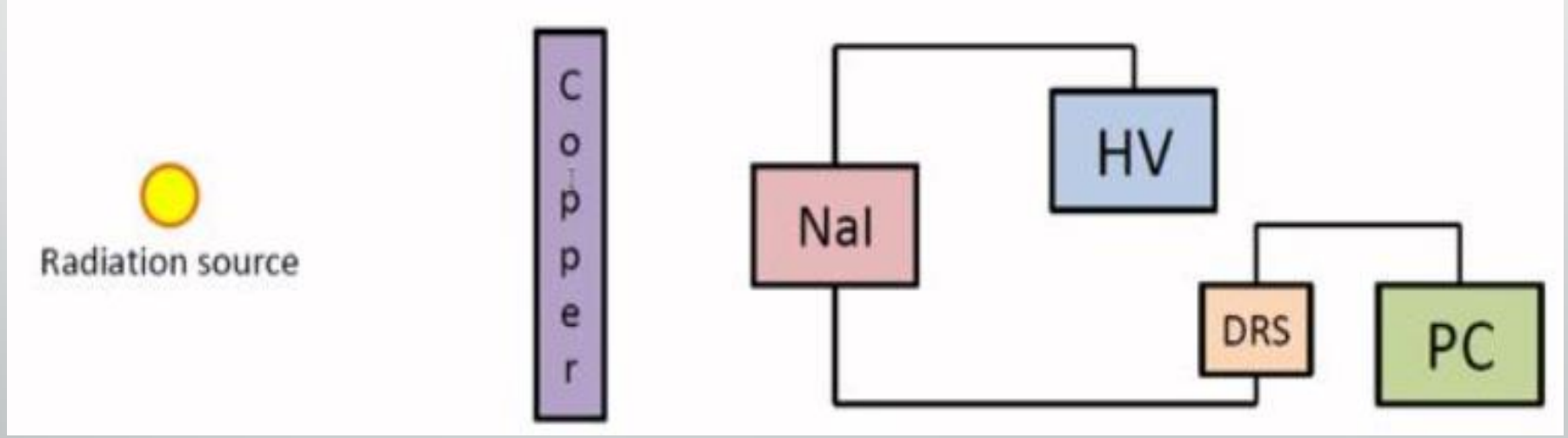
So it's ***Sn-125m***

Task 3: Attenuation Coefficient factor for Cu and Al

- ***Attenuation coefficient describes the fraction of a beam that is absorbed or scattered per unit thickness of the absorber.***

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

where μ is attenuation coefficient

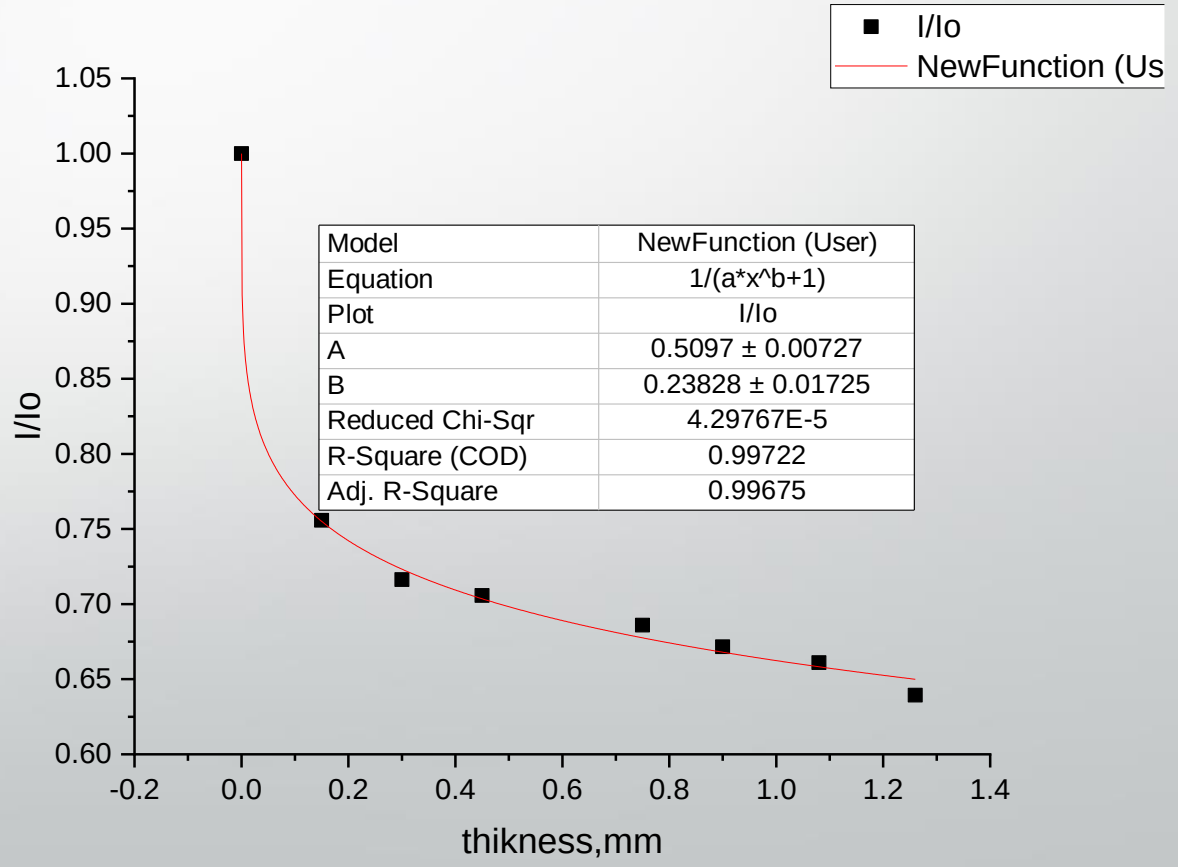


Experimental set-up

Task 3: Attenuation Coefficient factor for Cu and Al

1.Finding Al attenuation coefficient By using the given value in table , Using origin I plot the carve and fitting it according the equation y=1(a*x^b+1) as shown in fig.

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



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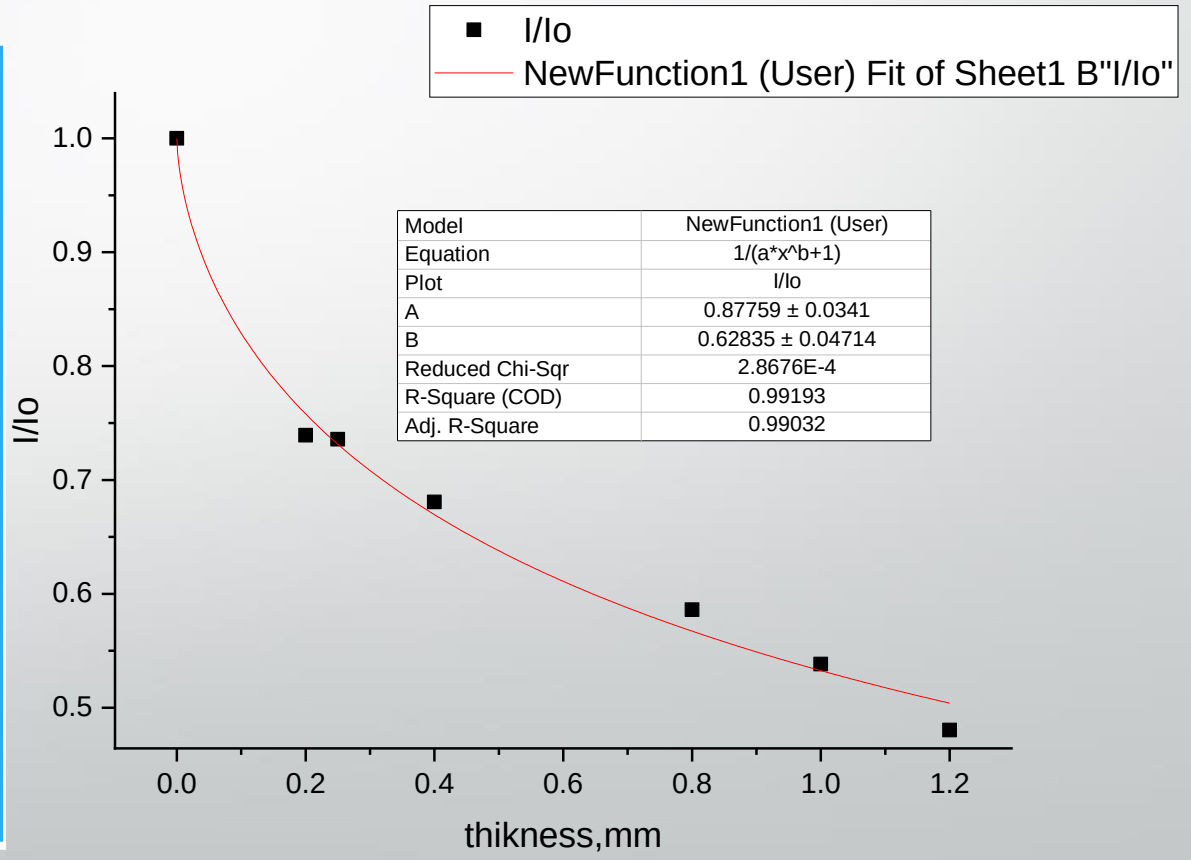
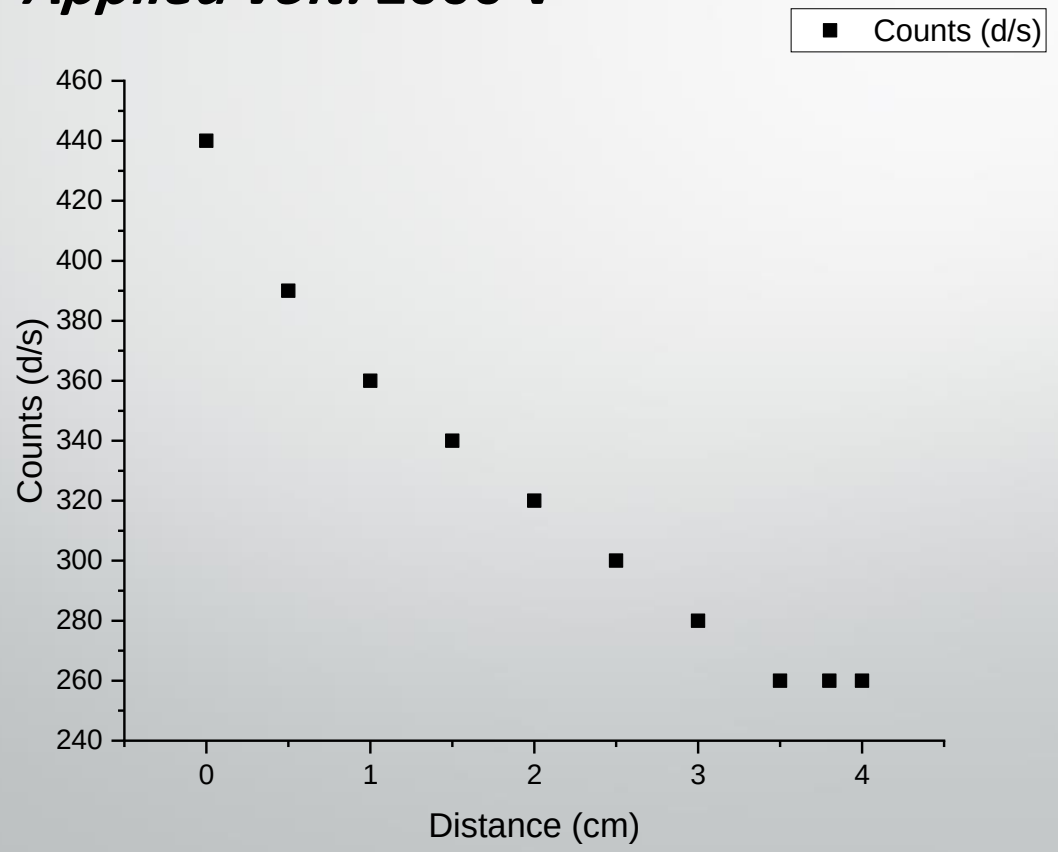
Thikness, cm	I/I0
0	1
0.2	0.73931
0.25	0.7357
0.4	0.68065
0.8	0.58611
1	0.53827
1.2	0.48042



Task 4: Alpha range in air

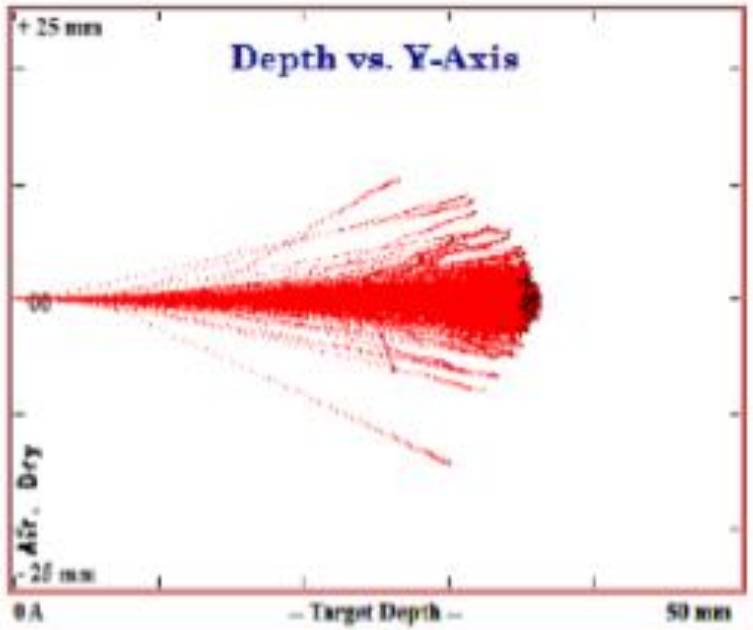
Source: **Pu239**
Energy of He: **5 MeV**
Detector: **Plastic**
Applied volt: **2000 V**



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

Task 4: Alpha range in air

Alpha Range in Air using Mont Carlo simulation SRIM



Source: Pu239 *Applied volt:* 2000 V

Energy of He: 5 MeV *Detector:* Plastic

Task 5: Pixel Detector

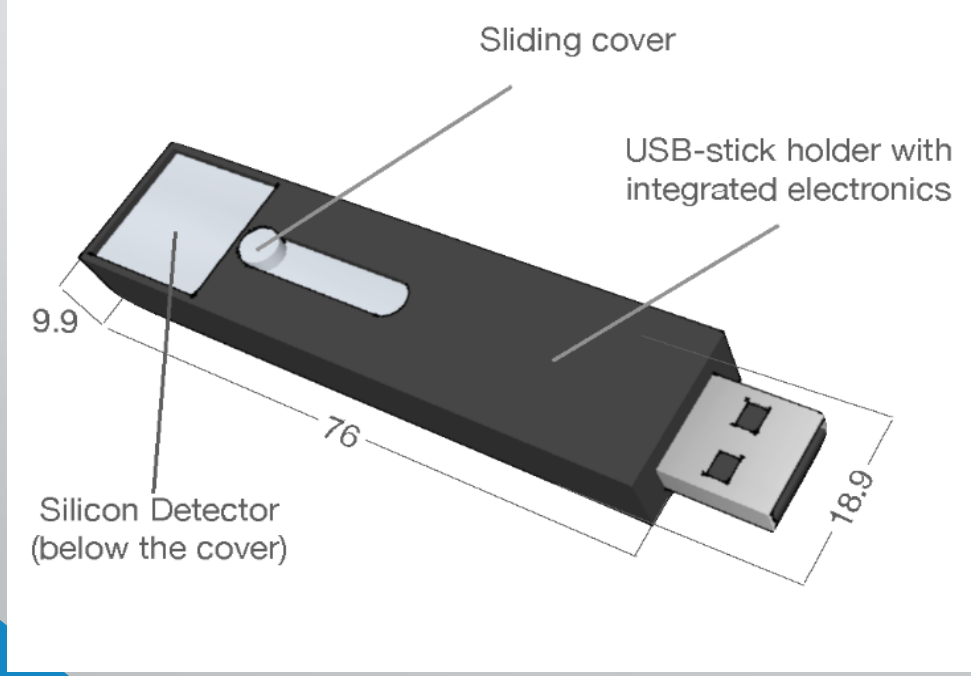
Hybrid pixel detectors are being consolidated as one of the best approaches for X-ray imaging techniques

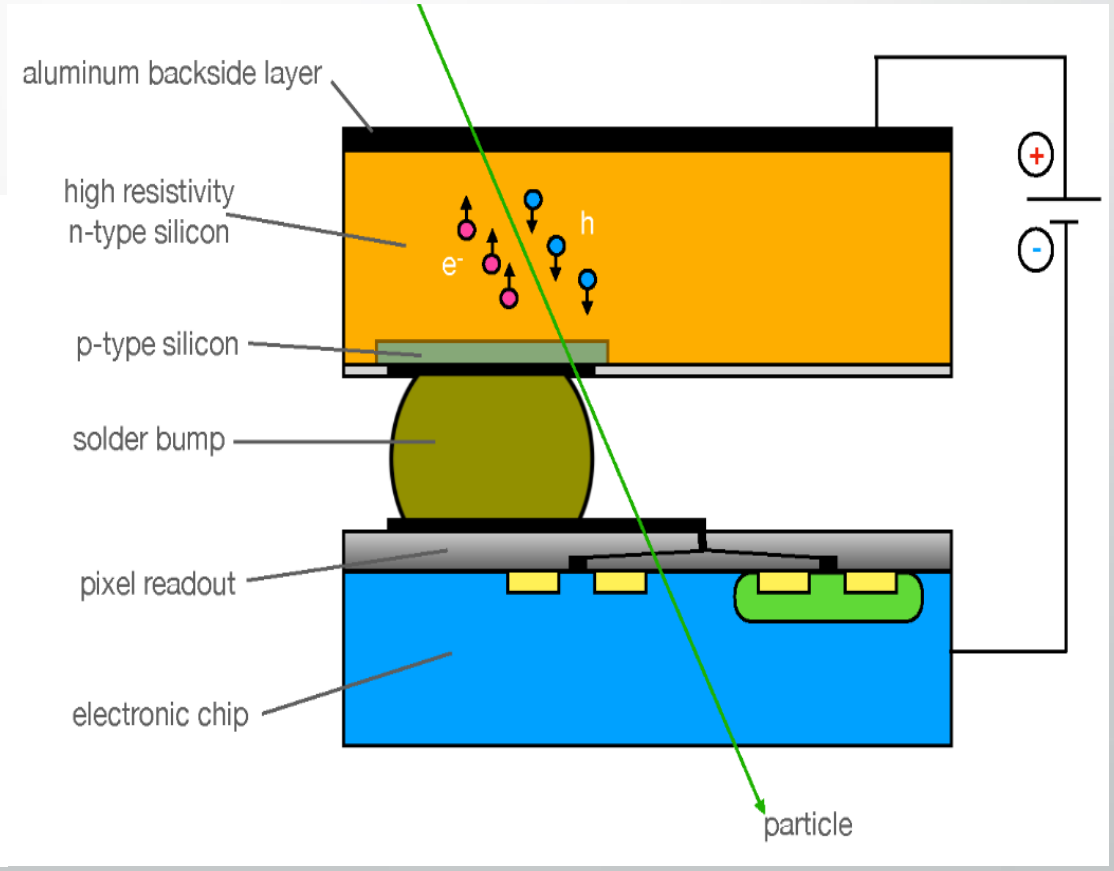
It consists of 3 parts:

-Sensor (Si)

-Electronic chip

-USB

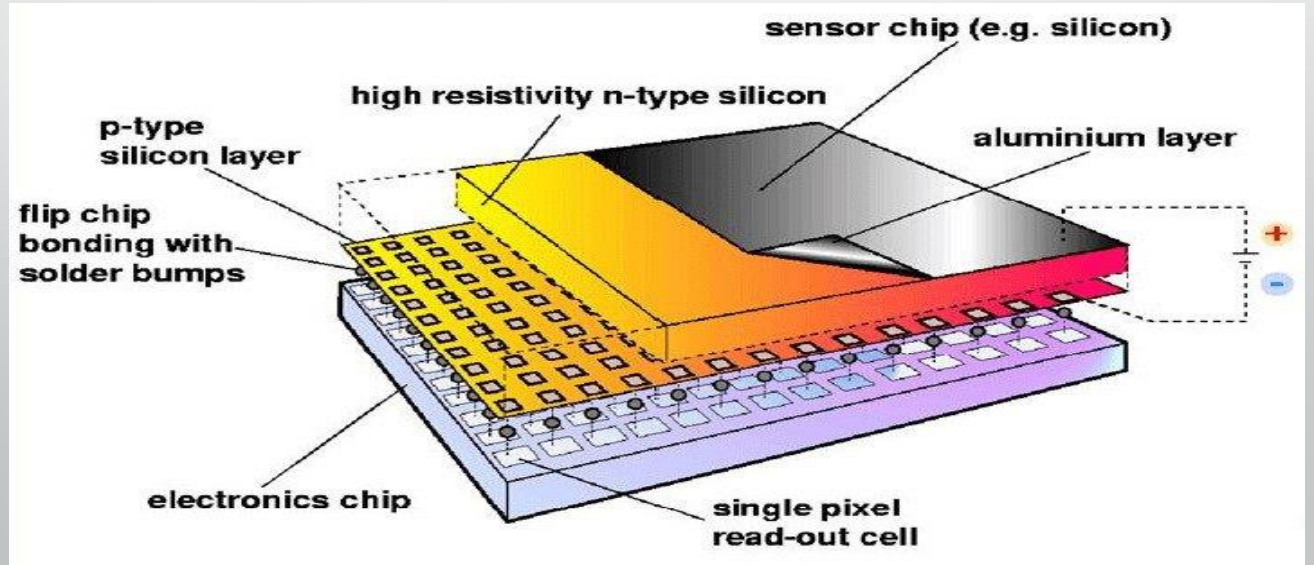




Task 5: Pixel Detector

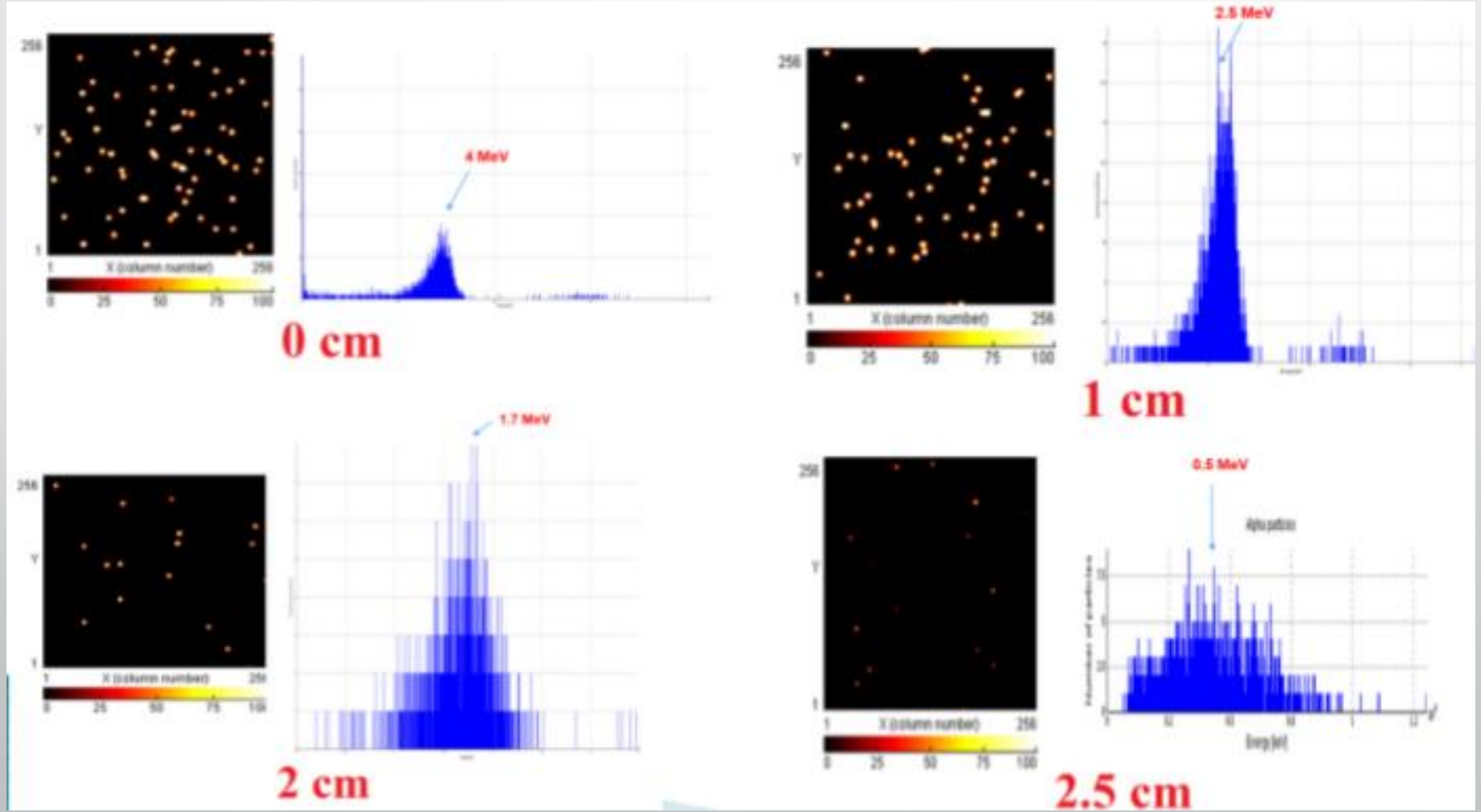
Specifications:

It The size of the sensor is 1.5x1.5 cm.
- 256 x 256 pixels (65.536 pixel).
-The pixel size is 55µm x 55µm.
- high resolution.
-used for registration different types of radiation



Task 5: Pixel Detector

Determination the range of alpha particles with (Am-241) energy 4MeV in Air by pixel detector:



Conclusion

1. Different types of radiation sources, and detection of radiation.
2. Radioactivity and naturally occurring radioactive materials NORM.
3. Energy calibration of some scintillation detectors by using Standard sources.
4. Identify of unknown source by using energy calibration curve.
5. Calculation of Resolution different scintillation detectors.
6. Determination of alpha range in air using Pixel and Plastic detectors.
7. Determination of Attenuation coefficient for different materials .
8. Assessment the ranges and energy of alpha particles using Monto Carlo simulation SIRM software.

THANK YOU

@INTEREST WAVE7 –Tarek Mohamed