Joint Institute for Nuclear Research
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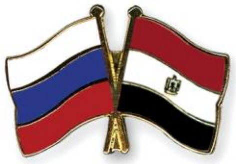

أكاديمية البحث العلمي والتكنولوجيا
Academy of Scientific Research & Technology

International Winter School at JINR Dubna, Russia

Radiation Protection and the Safety of Radiation Sources

Students:

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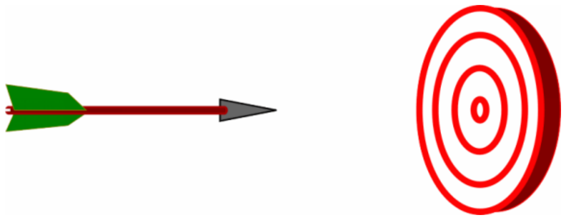
Laboratory of Nuclear Problems
JINR, Dubna, Russia

OUTLINE



- Purpose and General Concepts of our Project.
- Experimental Techniques.
    1. Scintillation Detectors BGO and NaI(Tl). Mitwalli
    2. Pixel Detectors. Rahma
    3. Attenuation of Gamma Radiation and Alpha Range. Refaat
- Outcome.

Purpose and General Concepts of Project:

1. Different types of radiation sources, and detection of radiation.
2. Limit dose and recommended radiation protection protocol from **UNSCEAR, ICRP, IAEA, NEA-OECD** etc.
3. Radioactivity and naturally occurring radioactive materials **NORM.**
4. Energy calibration of BGO and NaI(Tl) scintillation detectors by using Standard sources.
5. Identify of unknown source by using energy calibration curve.
6. Calculation of resolution for BGO and NaI(Tl) scintillation detectors.
7. Determination of alpha range in air using Pixel and Plastic detectors.
8. Determination of attenuation coefficient for Cu and Al Using Cs-137.
9. Assessment the range and energy of alpha particles using Monto Carlo simulation (SRIM software).

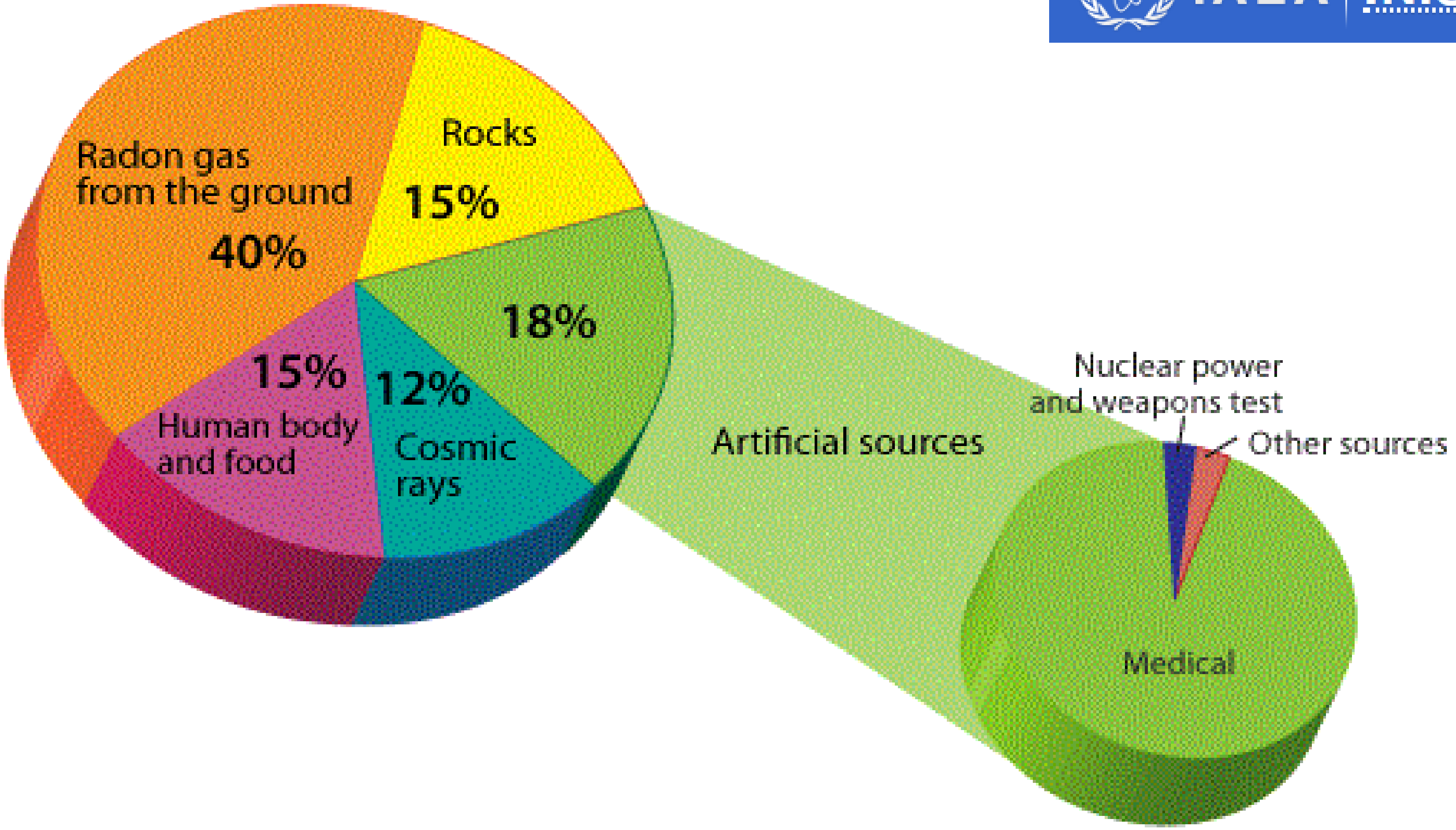
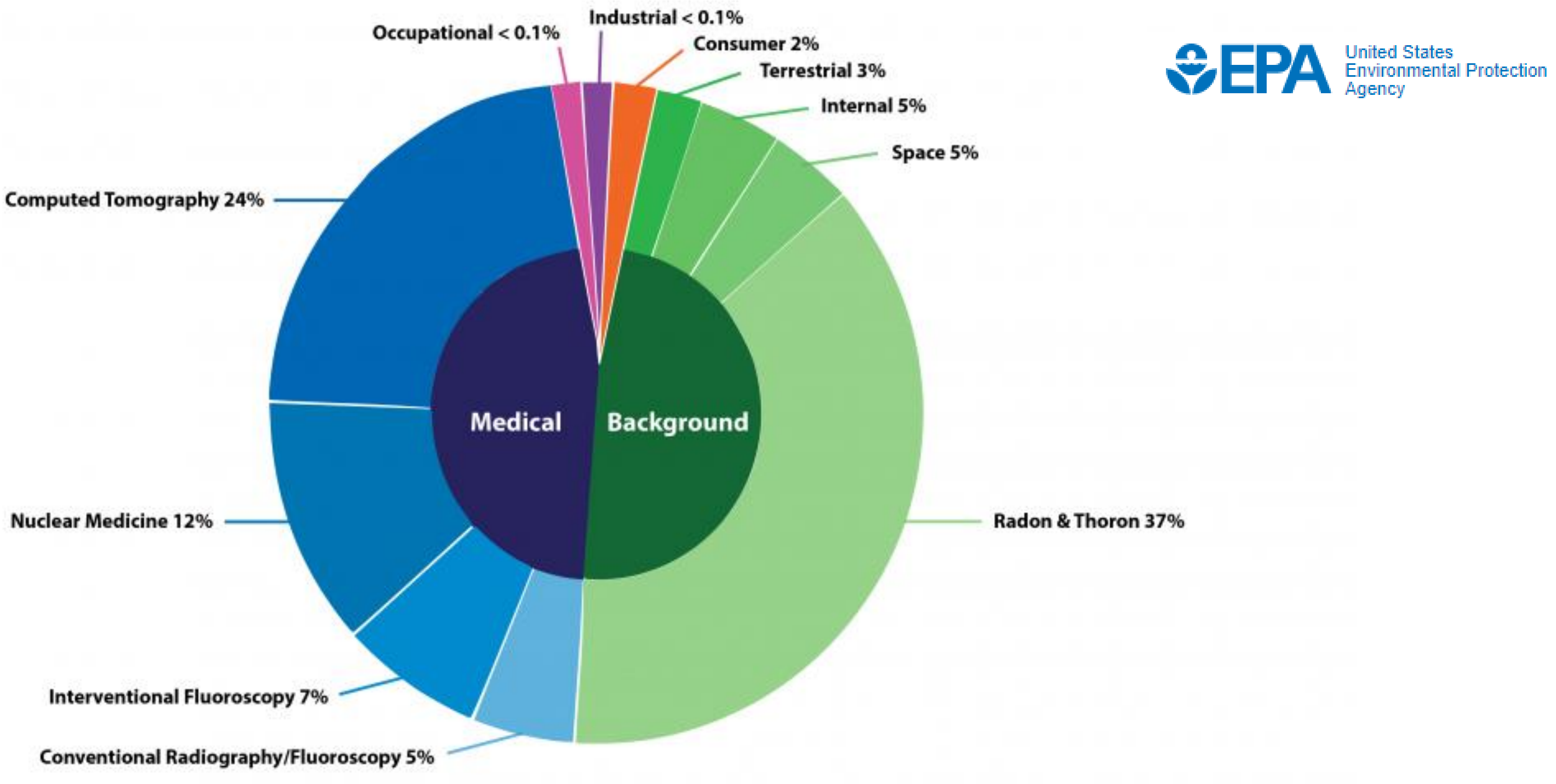


Fig. (1) Sources of Radiation Exposure.



Average Annual Radiation Dose

Sources	Radon & Thoron	Computed Tomography	Nuclear Medicine	Interventional Fluoroscopy	Space	Conventional Radiography/ Fluoroscopy	Internal	Terrestrial	Consumer	Occupational	Industrial
Units mrem (United States) mSv (International)	228 mrem 2.28 mSv	147 mrem 1.47 mSv	77 mrem 0.77 mSv	43 mrem 0.43 mSv	33 mrem 0.33 mSv	33 mrem 0.33mSv	29 mrem 0.29 mSv	21 mrem 0.21 mSv	13 mrem 0.13 mSv	0.5 mrem 0.005 mSv	0.3 mrem 0.003 mSv

Fig. (2) Equivalent dose of Radiation.

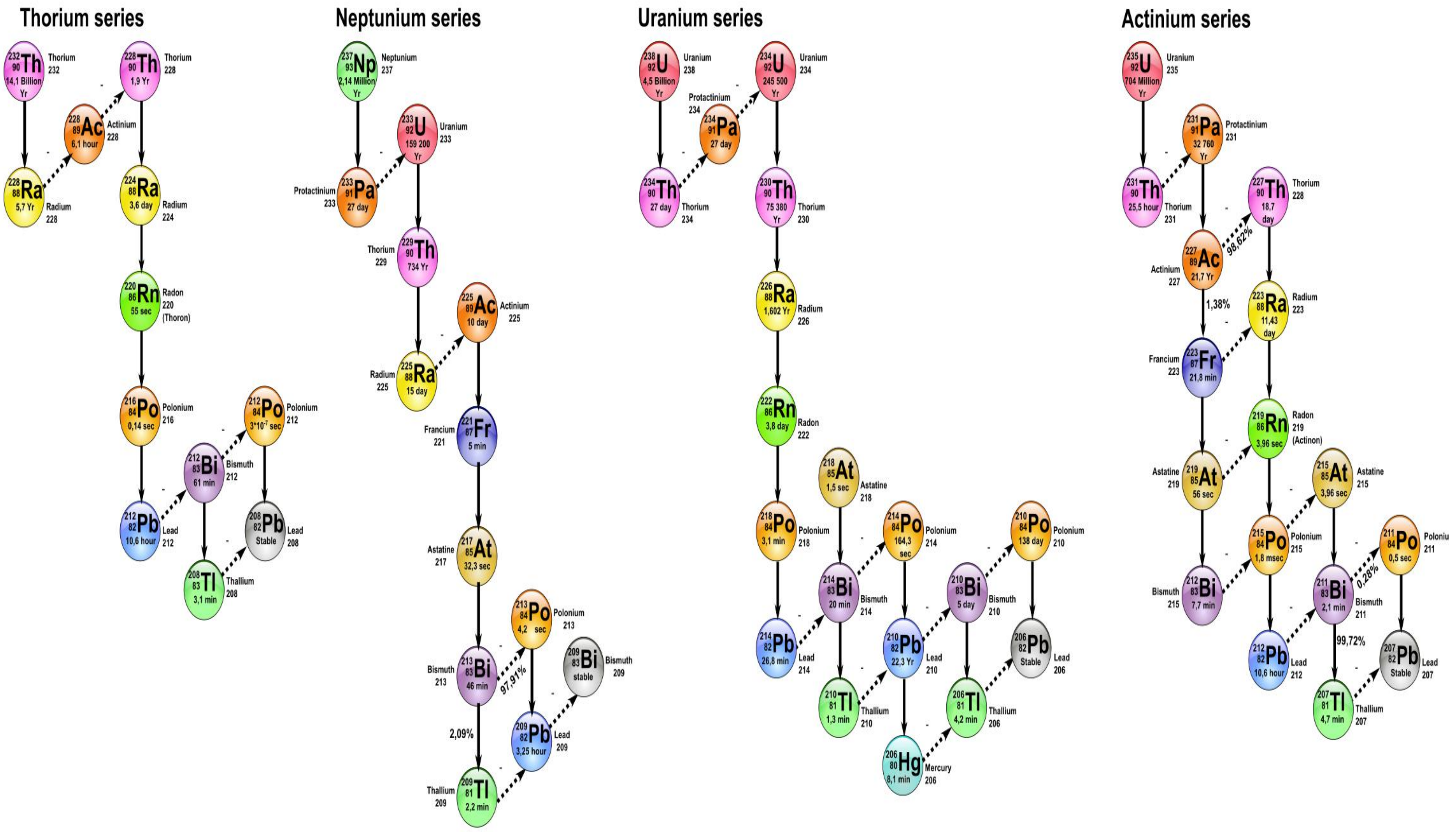


Fig. (3) Nature Radioactive Decay Series.

The First Part

Experimental Techniques

1. Scintillation detectors NaI(Tl) and BGO

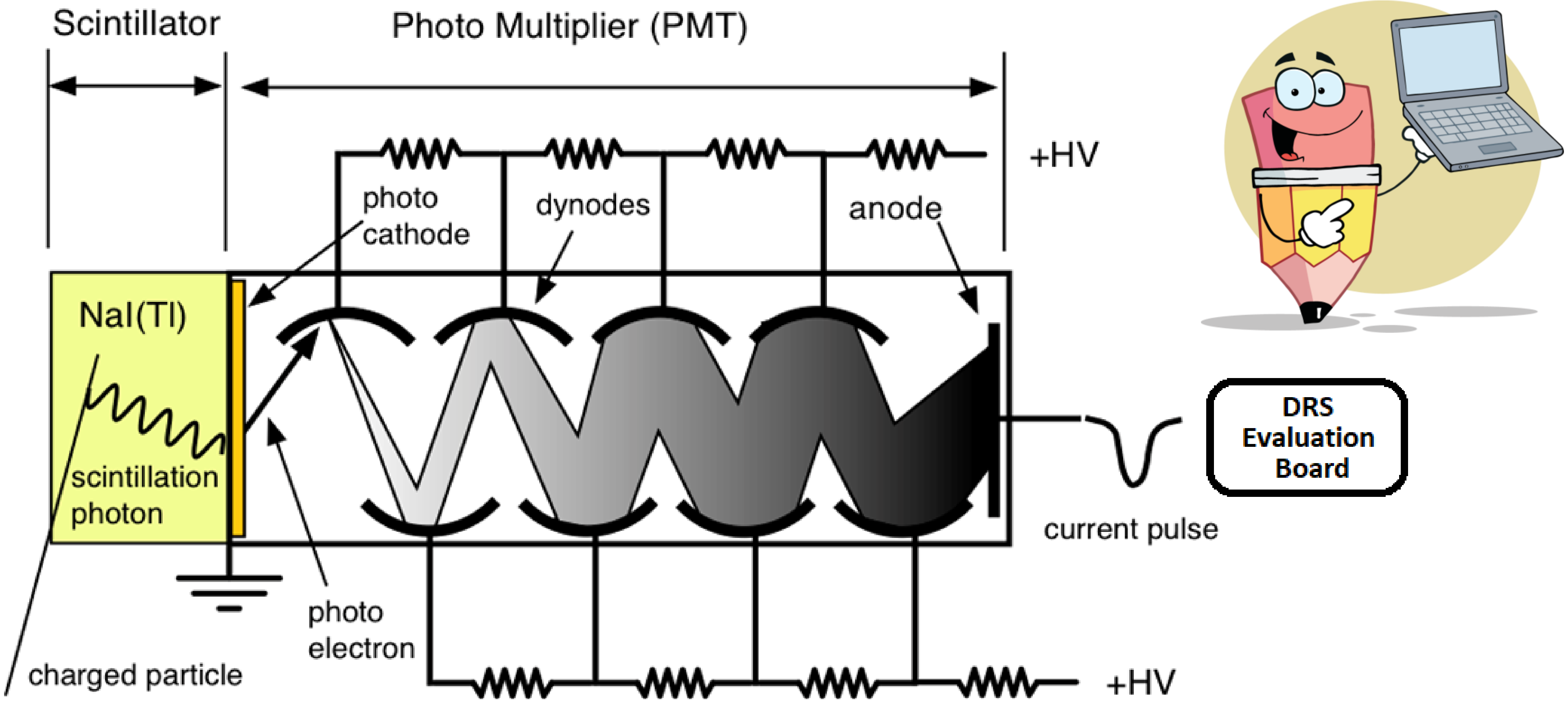


Fig. (4) NaI(Tl) Scintillation detectors.

Assignment No. 1

Determination of the best applied voltage and Show the resolution of NaI(Tl) Scintillation detector by using **Co-60** Standard Sources.

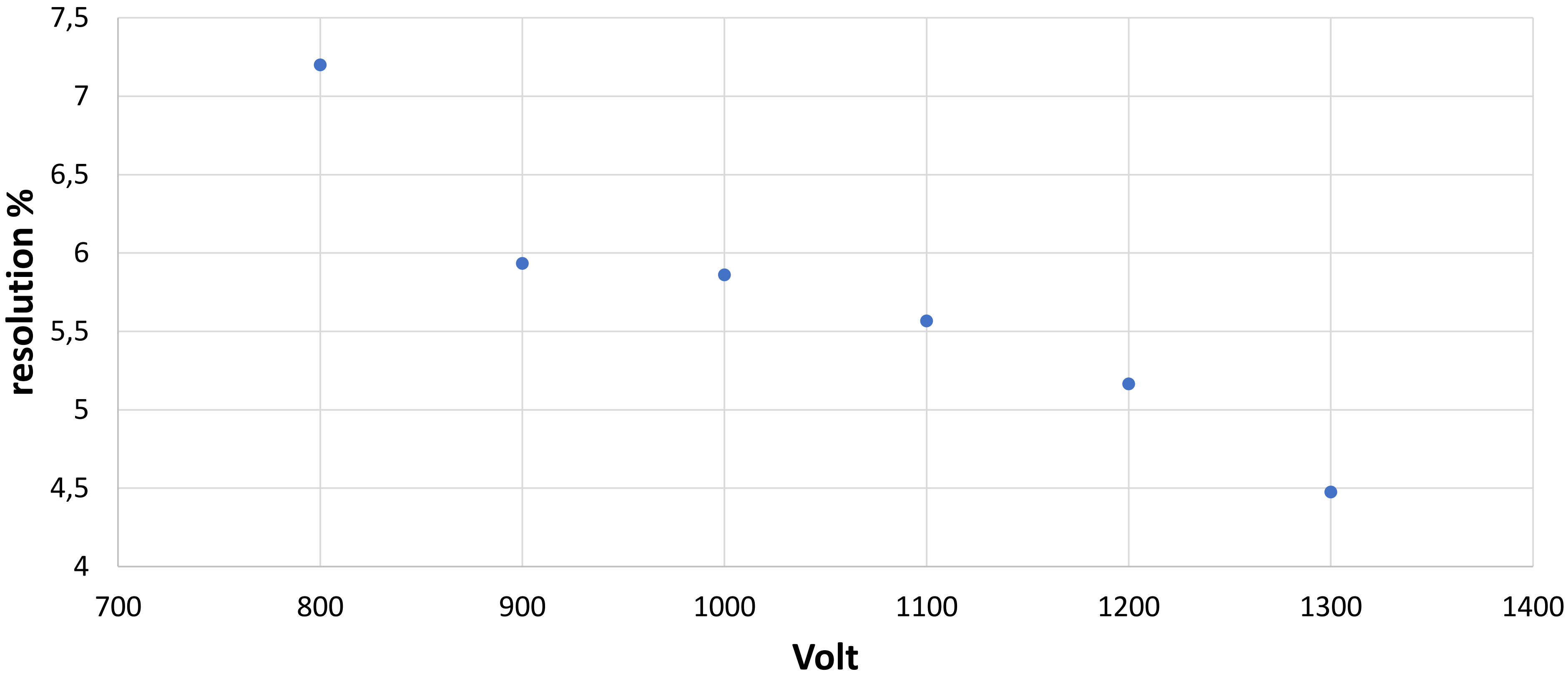


Fig. (5) The relation between the resolution and applied volt for NaI(Tl) Scintillation detector.

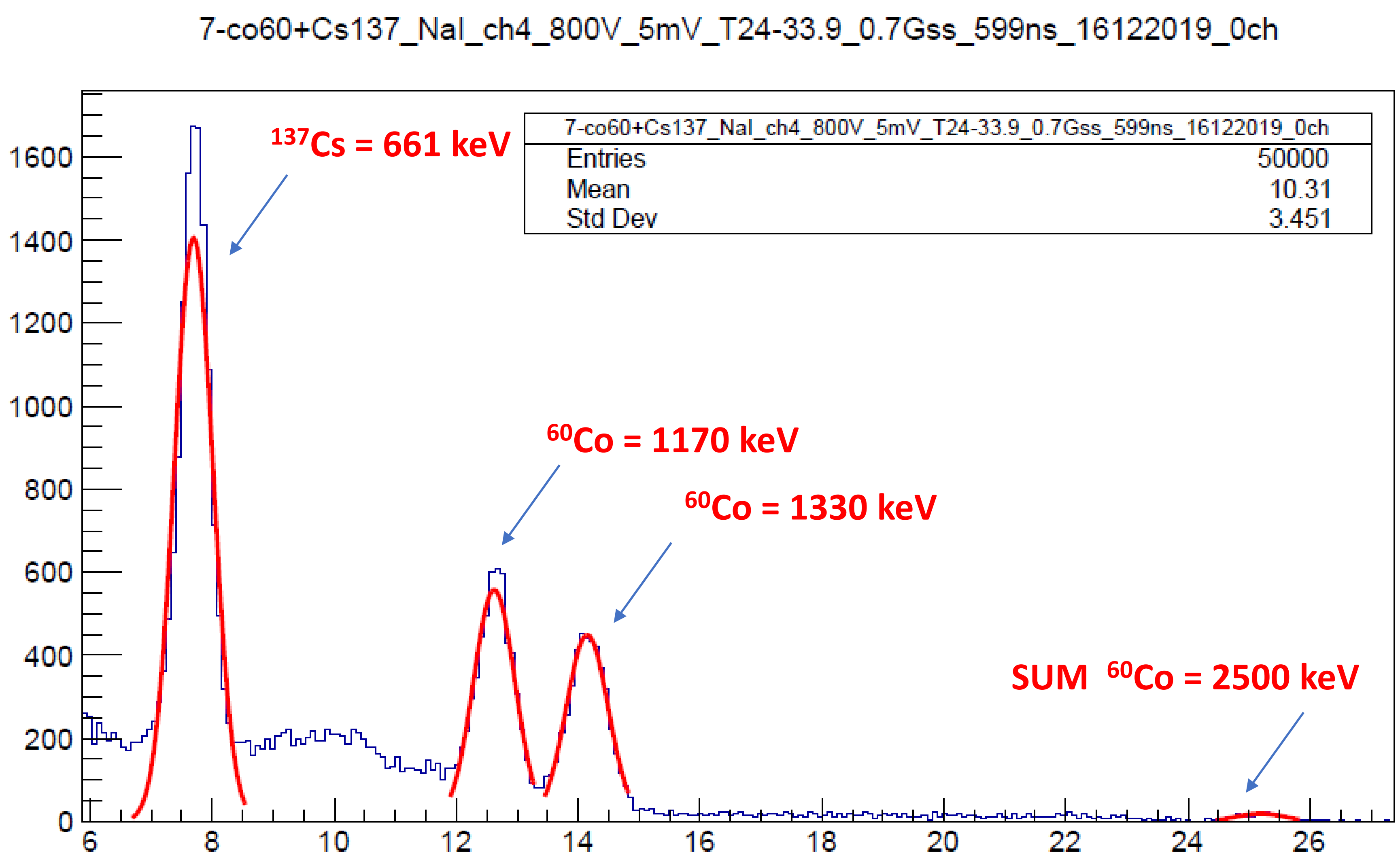


Fig. (6) Spectrum of **Cs-137** and **Co-60** by using **NaI (Tl)** scintillation detector at 1400 V and 5 mV and DRS software.

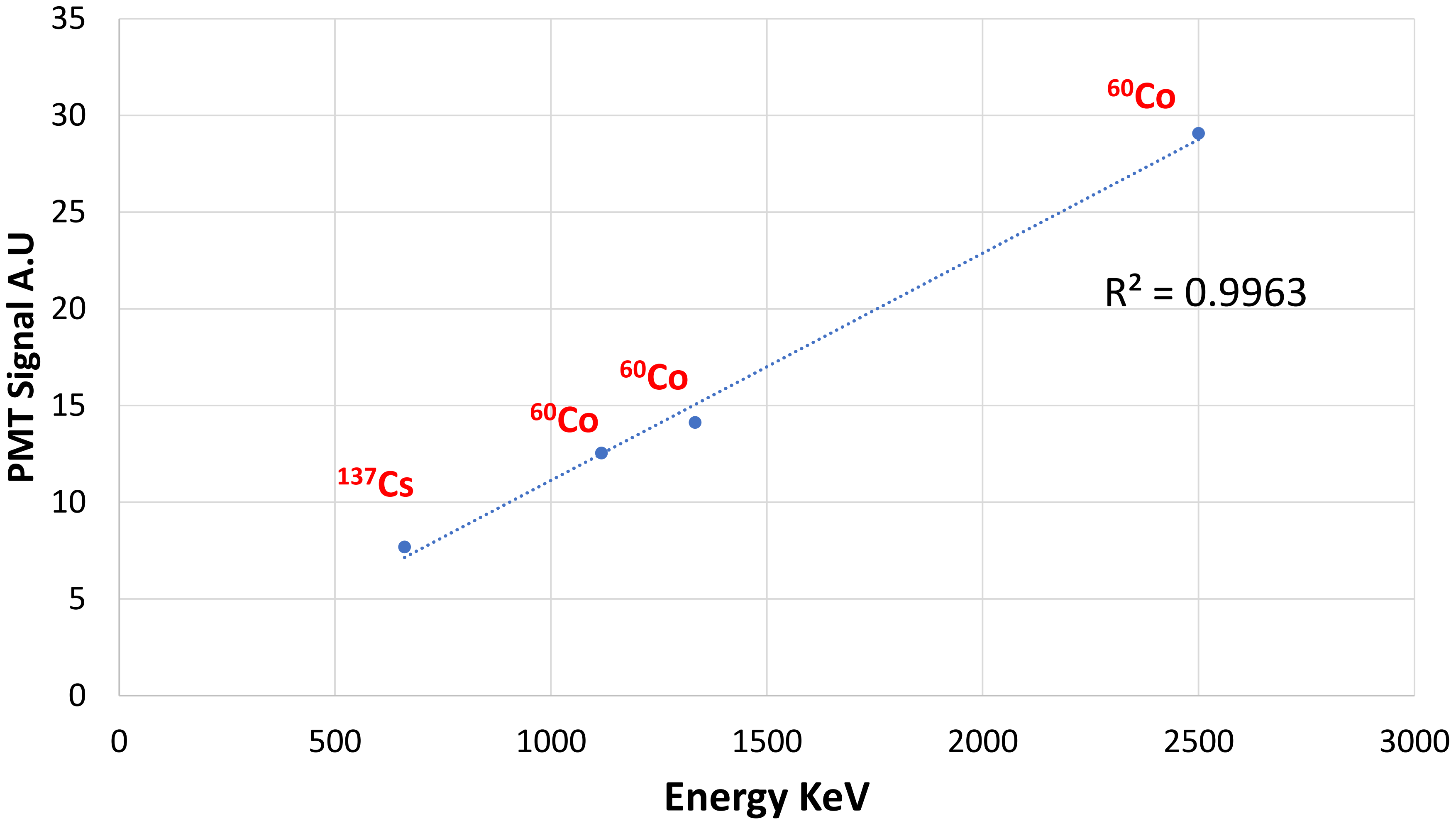


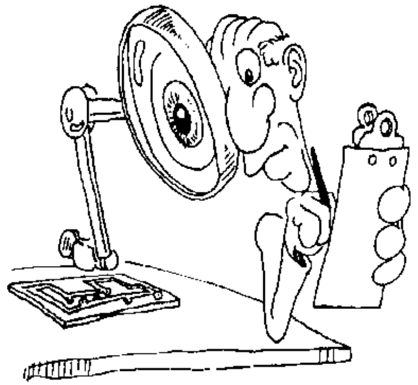
Fig. (7) Energy channel calibration curve for NaI(Tl) detector using Co-60 and Cs-137 standard source.

Assignment No. 2

Identify of unknown source (A and B), and Show the resolution of detector by using several sources Cs, Co, A, B Standard Sources.

From Liner energy calibration curve we can determine energy peak foe each unknown source by using previous equation calibration curve for NaI(Tl) scintillation detector as the same parameters.

$$Y = (0.0098\ X) + 1.3316$$



Where: Y is the PMT signal A.U,

X is the energy for unknown source

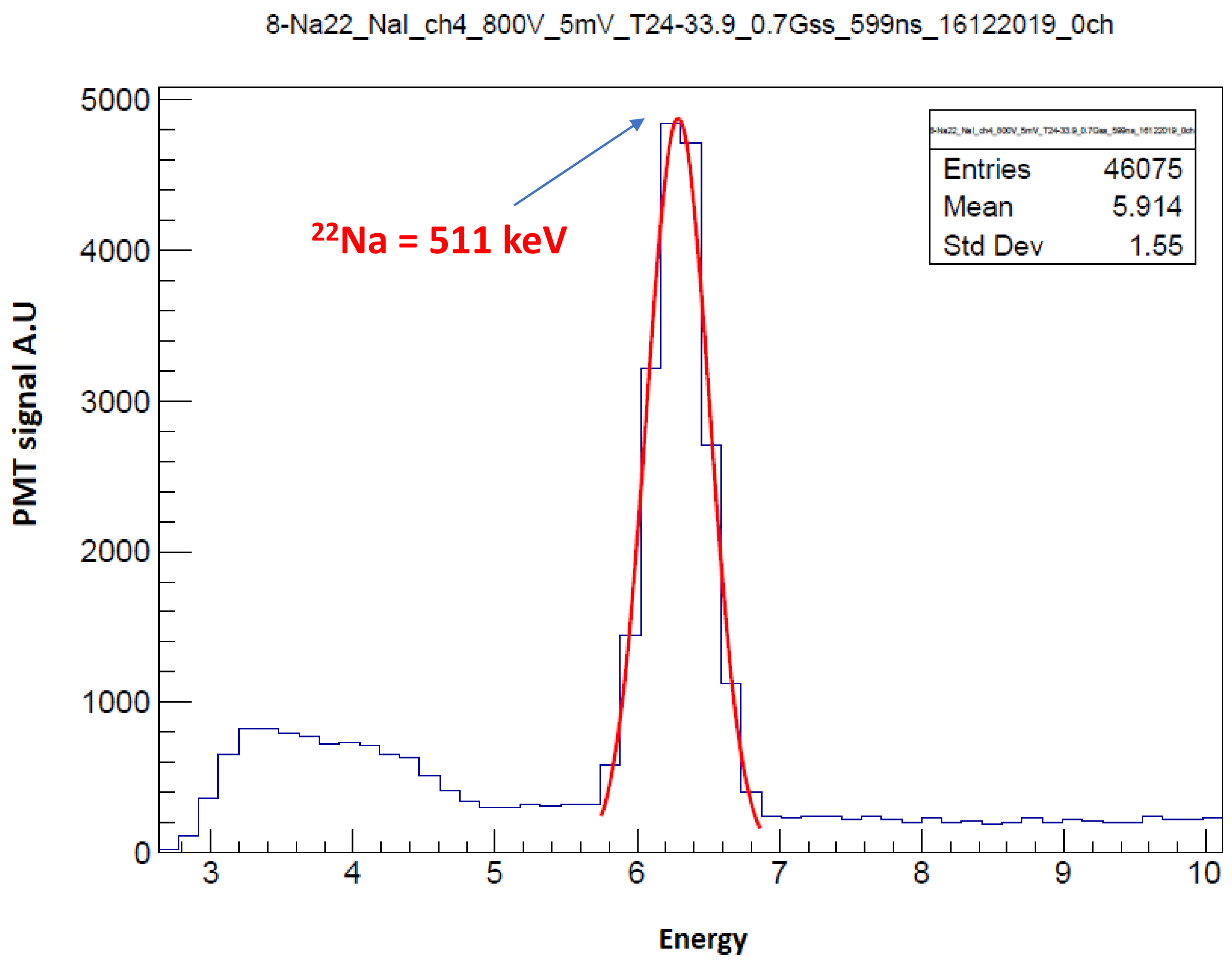


Fig. (8) Spectrum of Na-22 by using NaI(Tl) scintillation detector at 1400 V and 5 mV and DRS software.

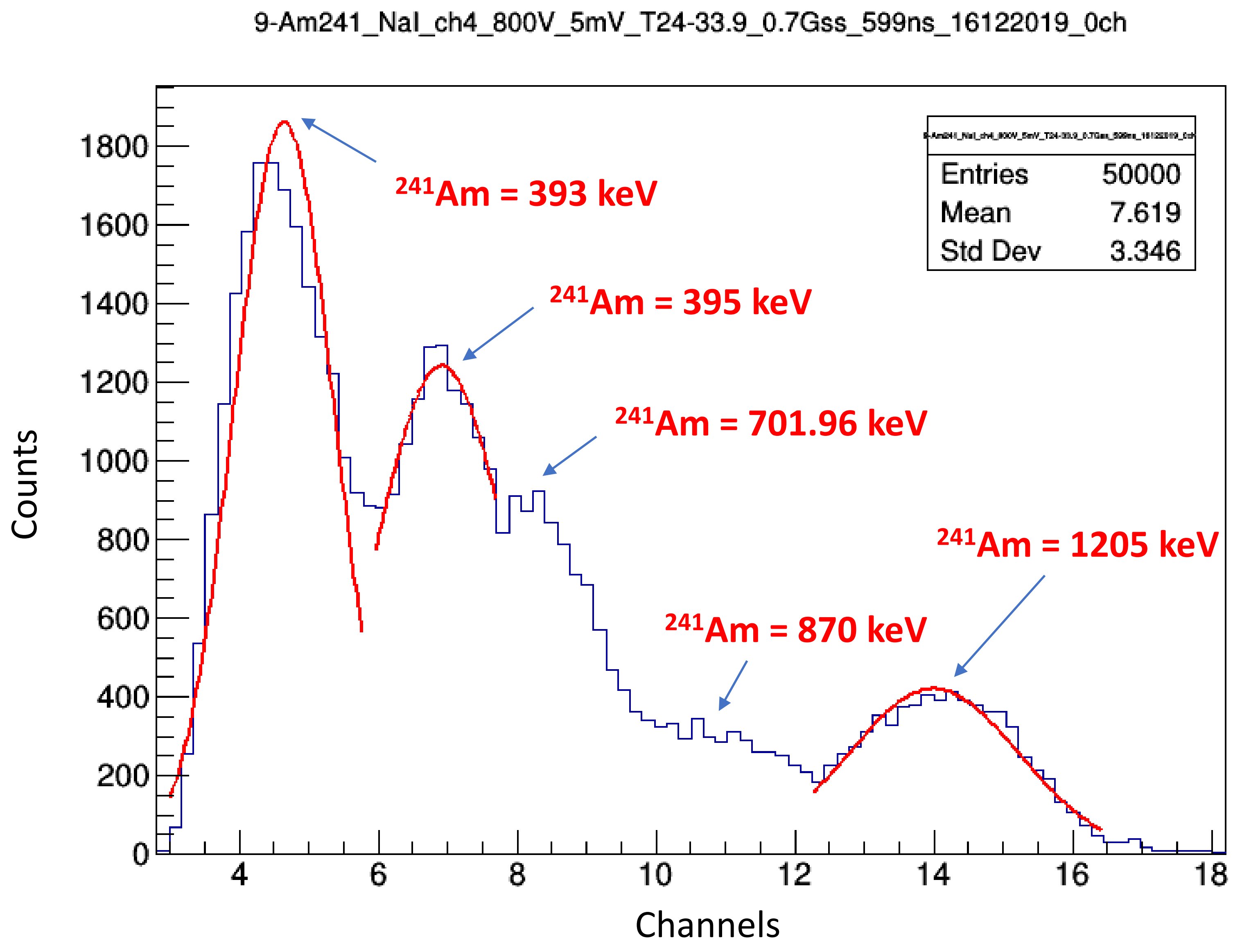


Fig. (9) Spectrum of Am-241 by using NaI(Tl) scintillation detector at 1400 V and 5 mV from DRS software.

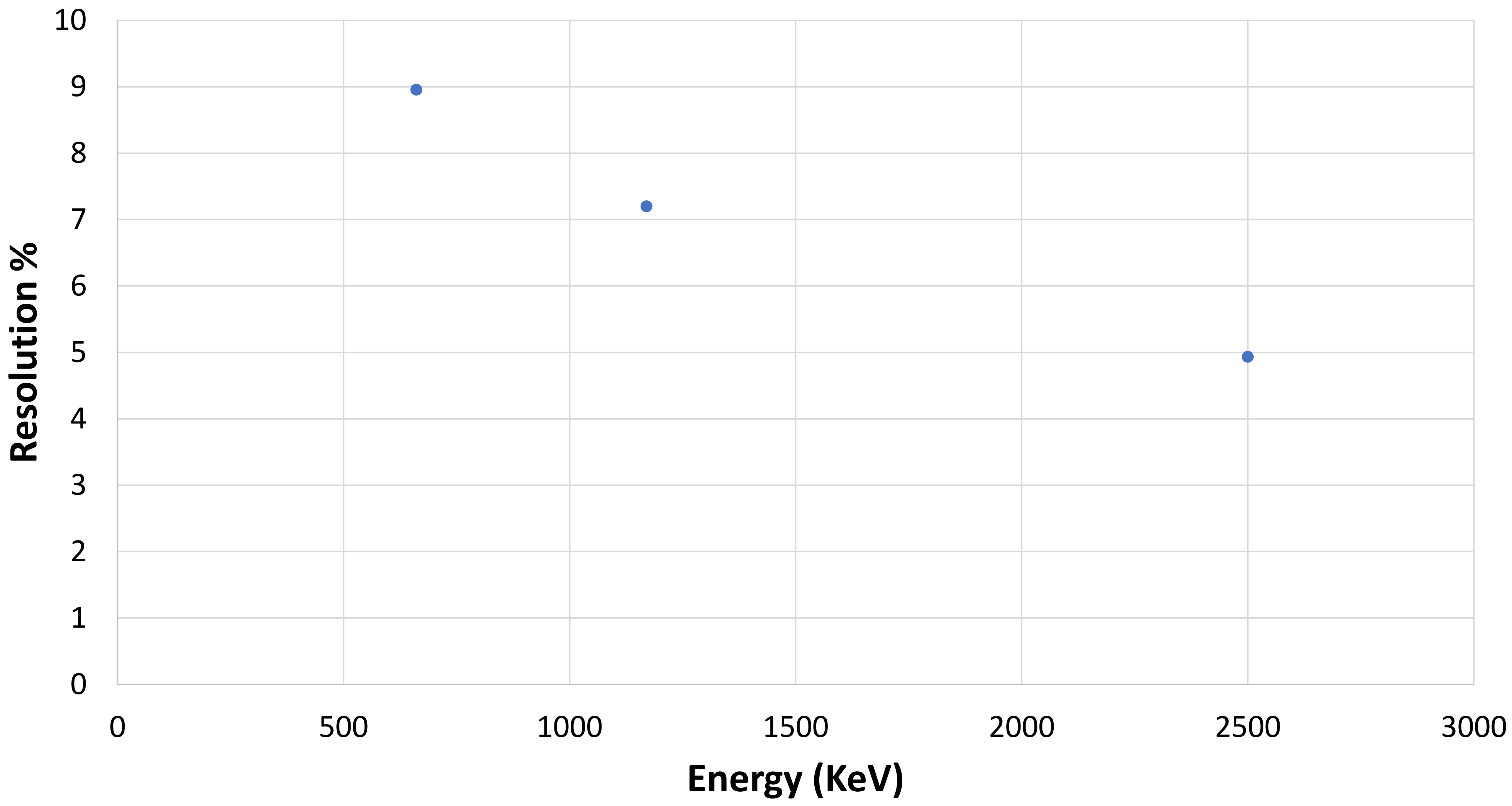


Fig. (10) The relation between the resolution and energy of peak for NaI(Tl) scintillation detector **C0-60 and Cs-137**

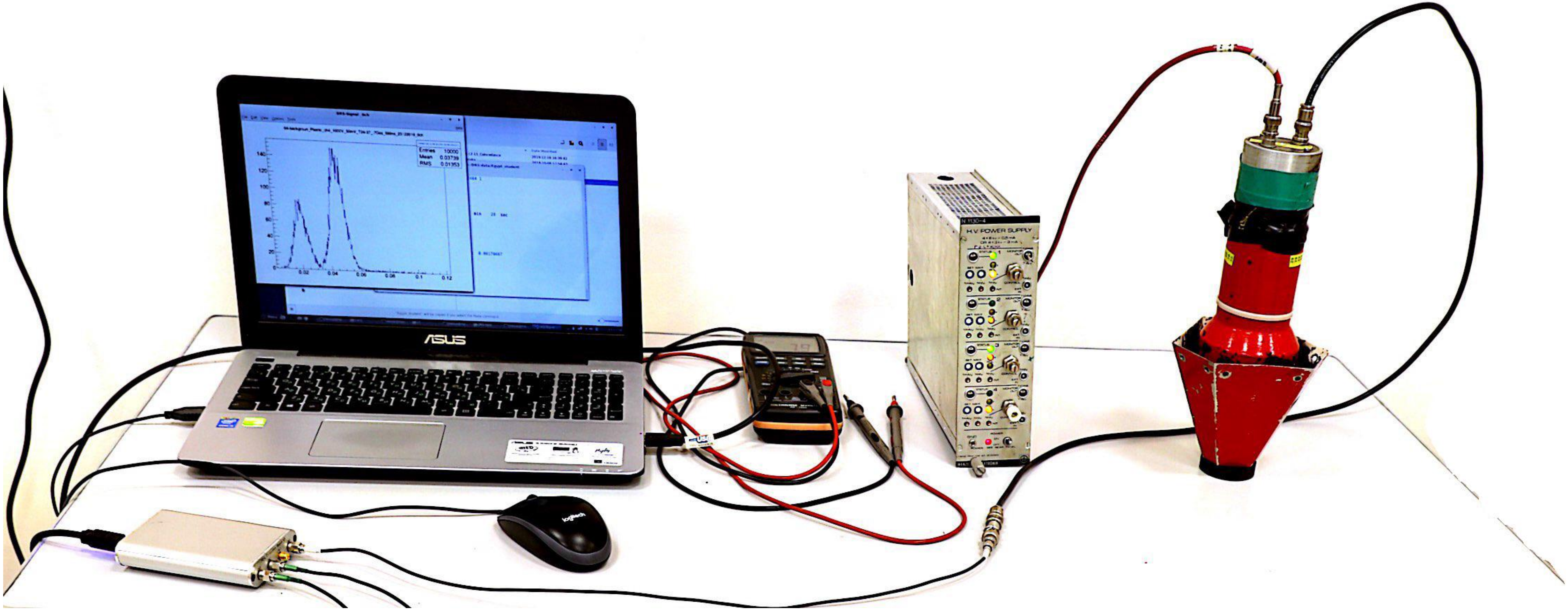


Fig. (11) BGO Scintillation detectors

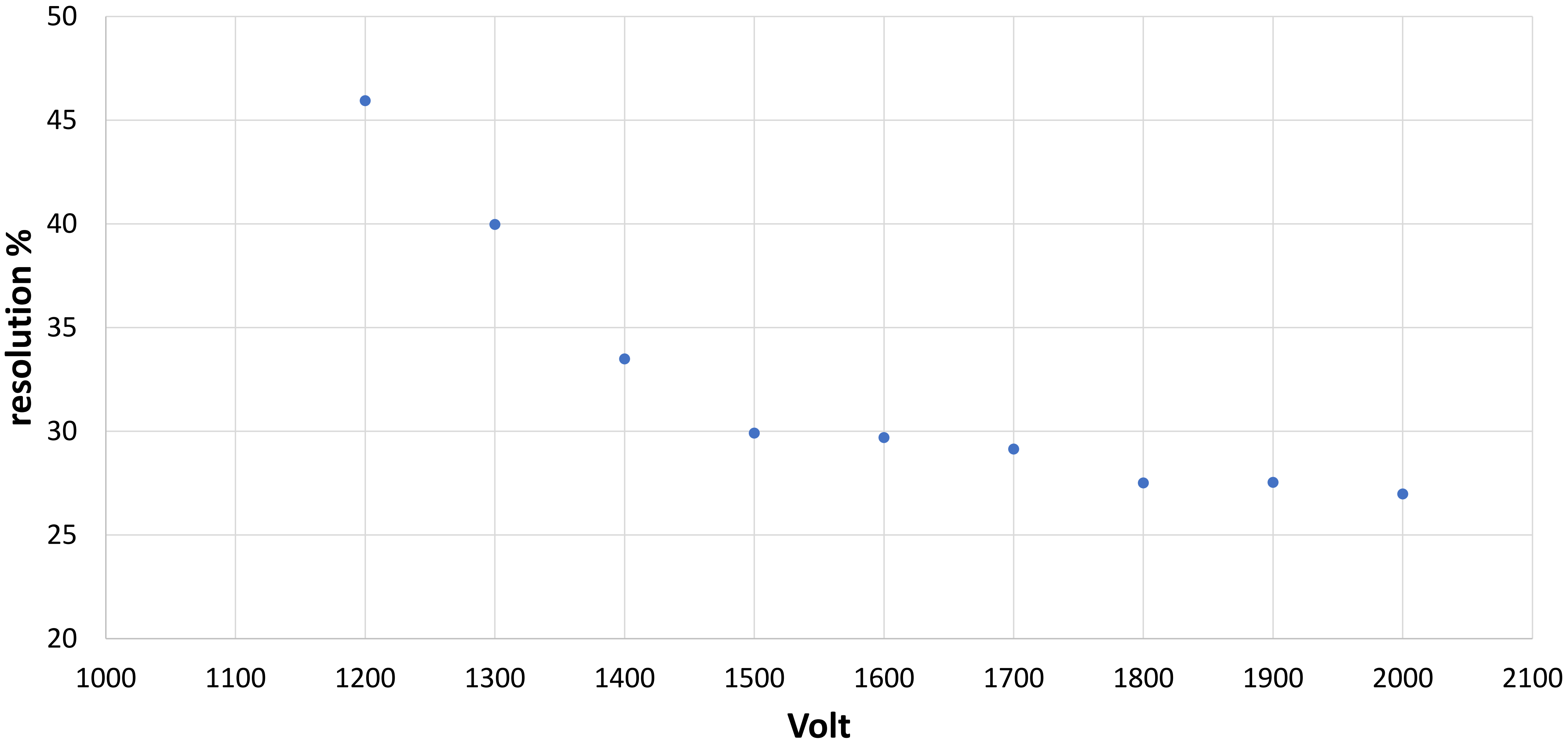


Fig. (12) The relation between applied volt and the resolution for BGO detector

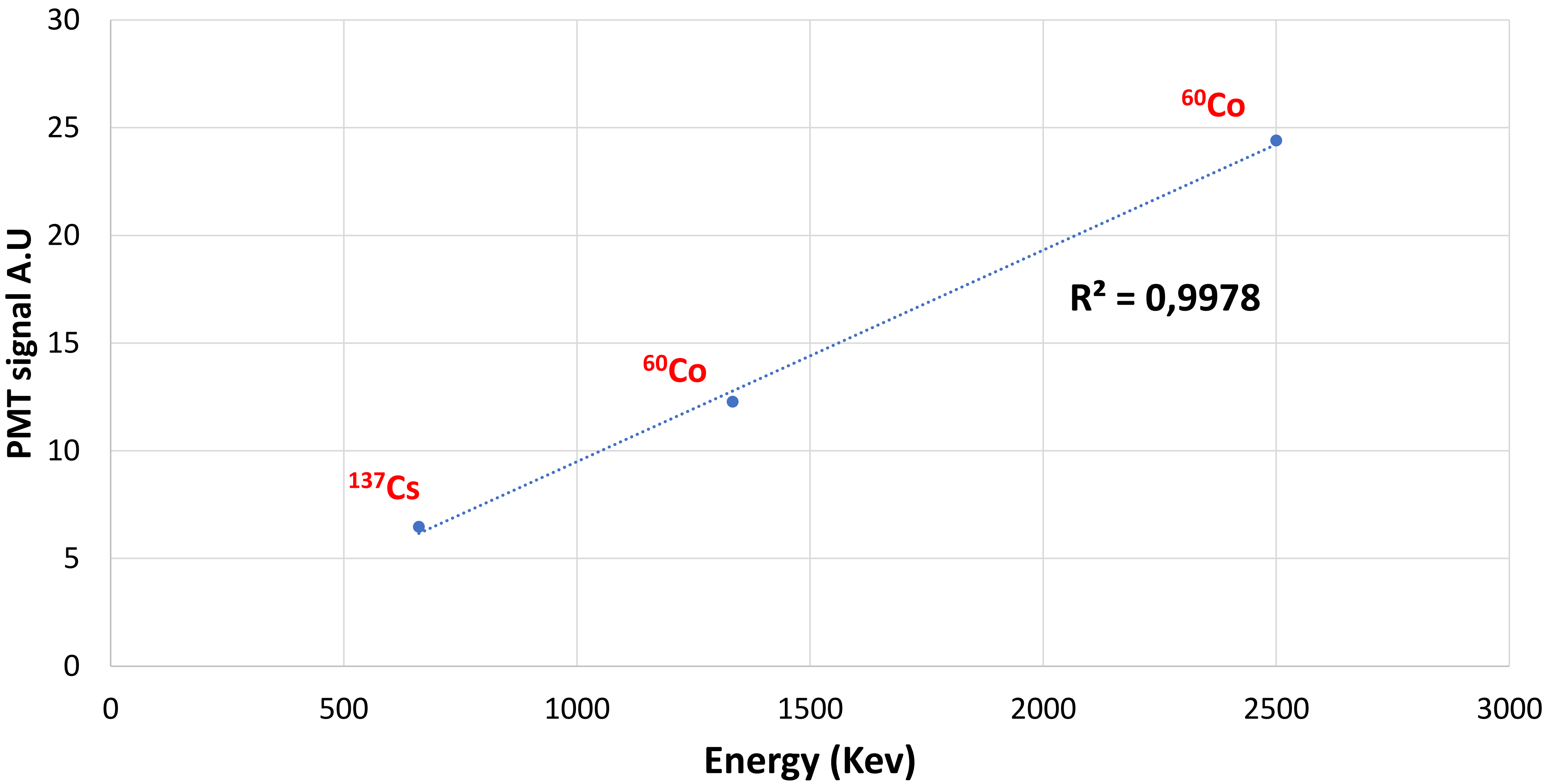


Fig. (13) Energy channel calibration curve for BGO detector using Co-60 and Cs-137 standard source.

The second Part

Pixel Detector

- It is an advanced detector like a digital camera.
- It consists of two parts:

  1- **Sensor** (Si)   2- Electronic chip

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

  (x- ray, gamma, electron, neutron and charged particles).

Fig (14)

Task one

- Determination the range of **Alpha** particles with (Am-241) energy about 4 MeV in air using pixel detector.

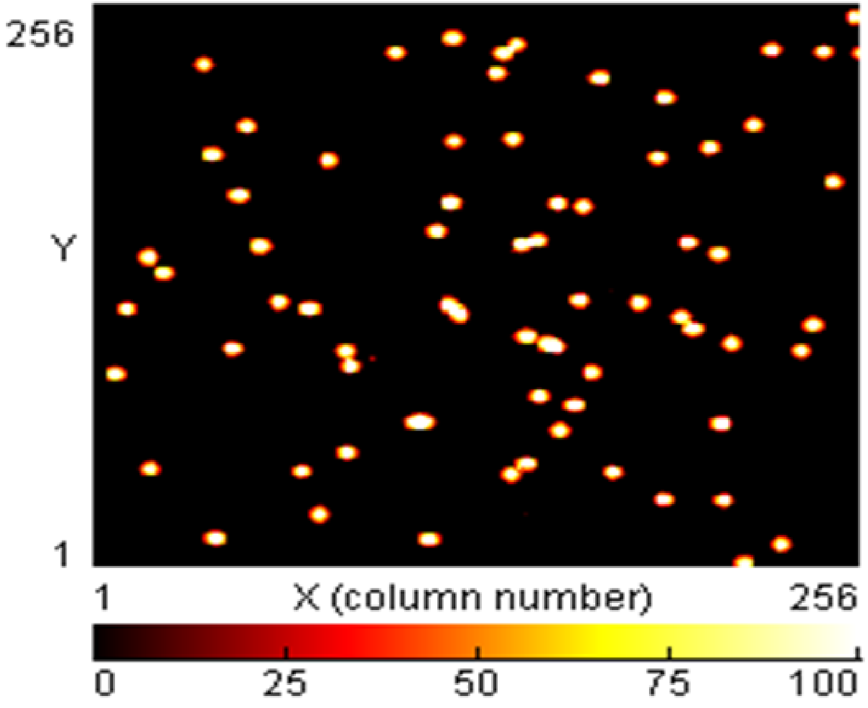


Fig. (15.a)

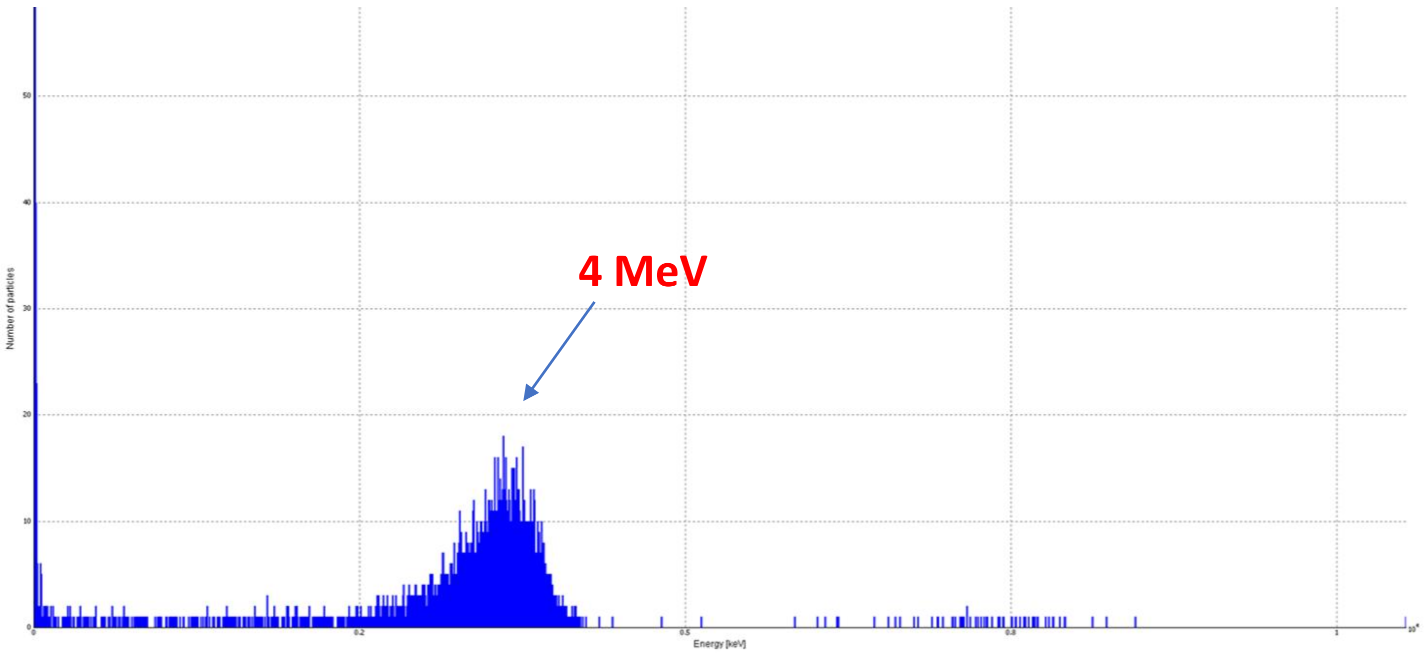


Fig. (15.b)

Fig (15) Absorption of alpha particle energy in the air at zero cm

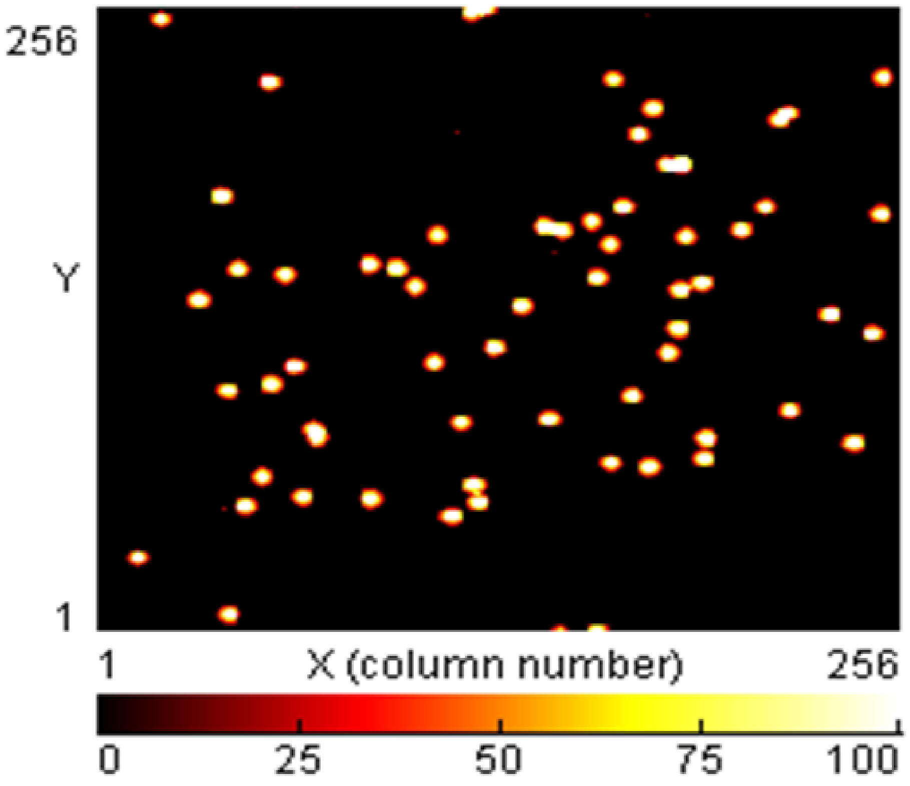


Fig. (16.a)

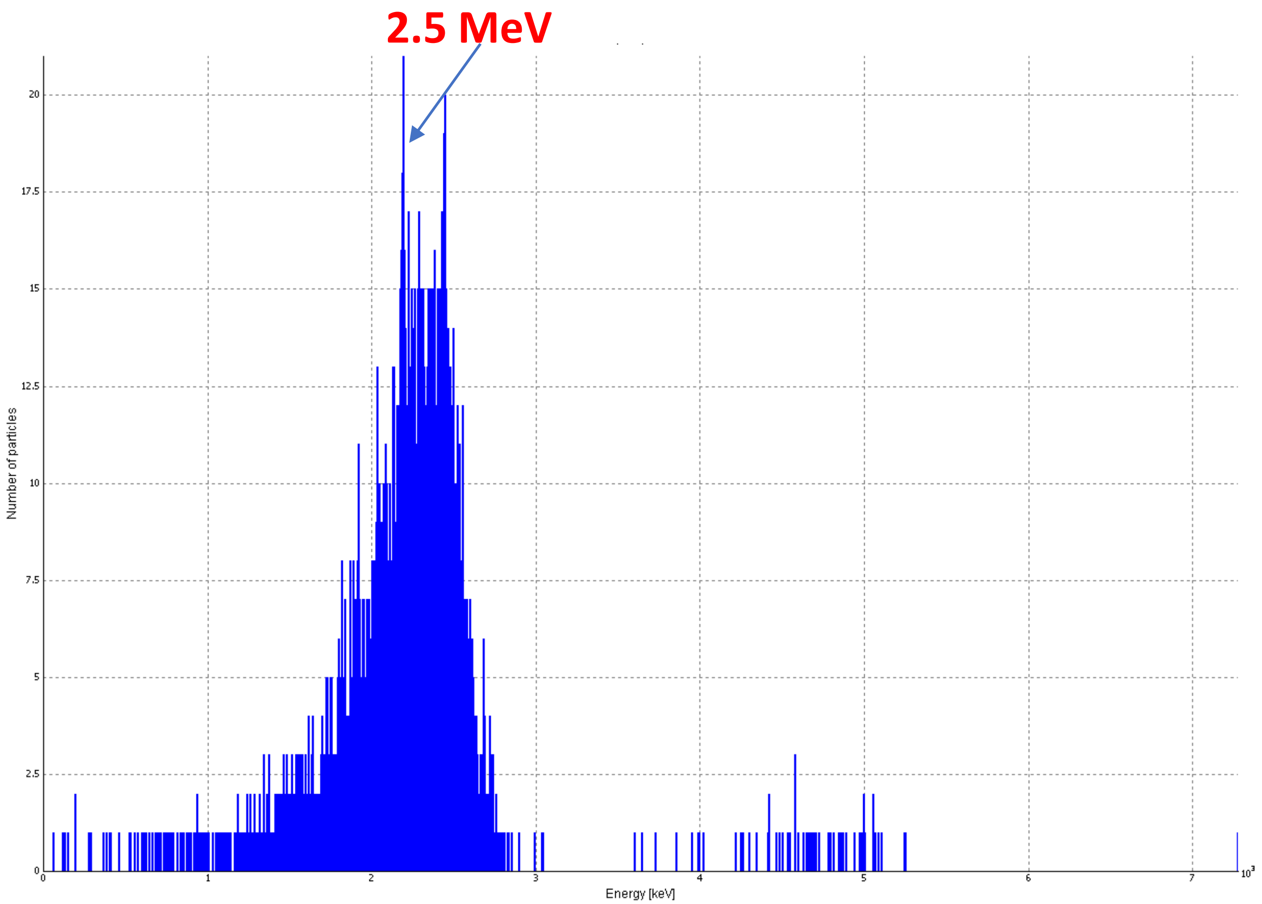


Fig. (16.b)

Fig. (16) Absorption of alpha particle energy in the air by moving the alpha source away by 1 cm

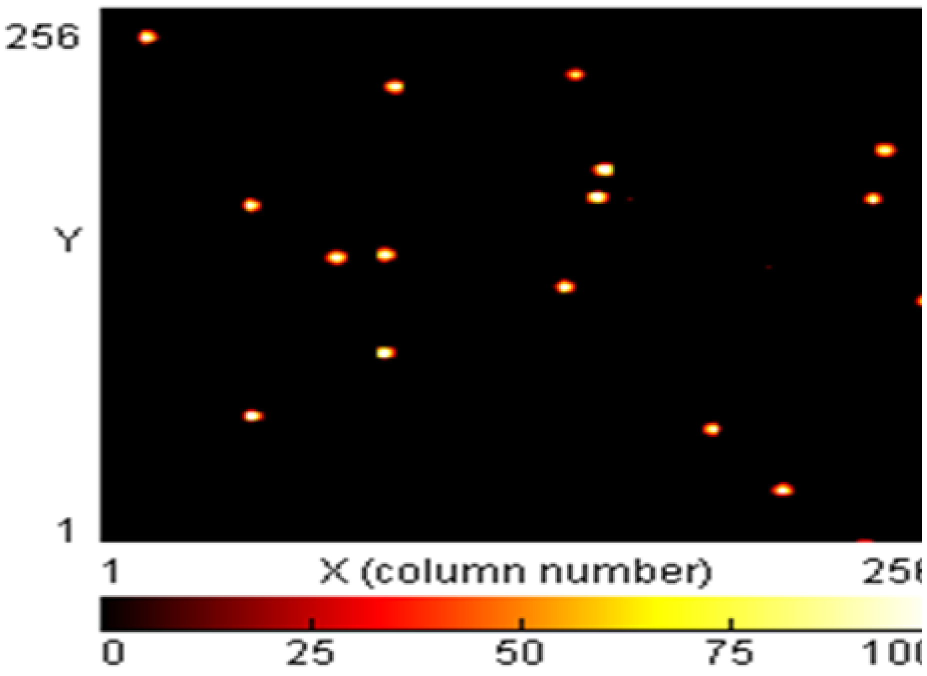


Fig. (17.a)

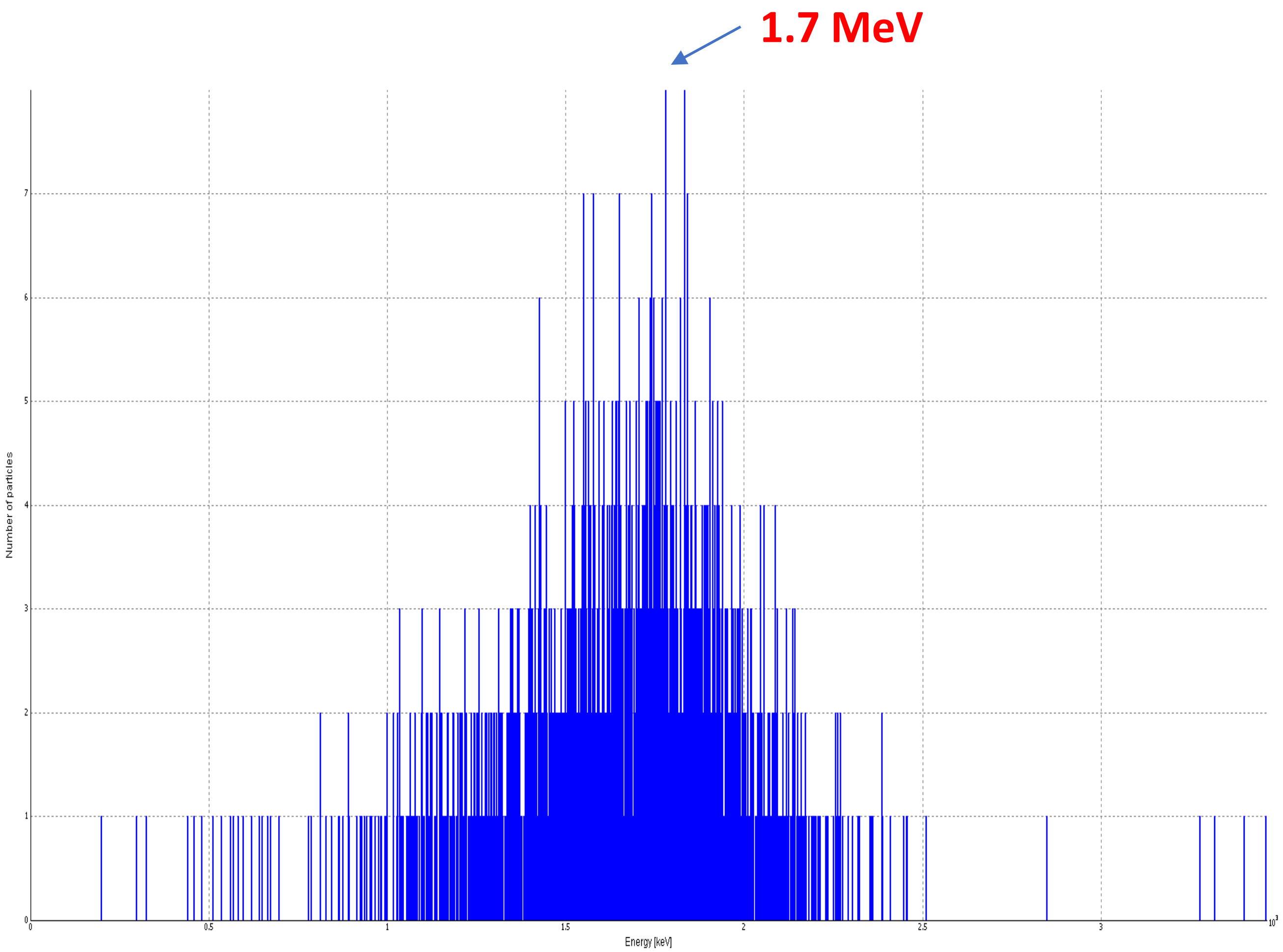


Fig. (17.b)

Fig. (17) Absorption of alpha particle energy in the air by moving the alpha source away by 2 cm

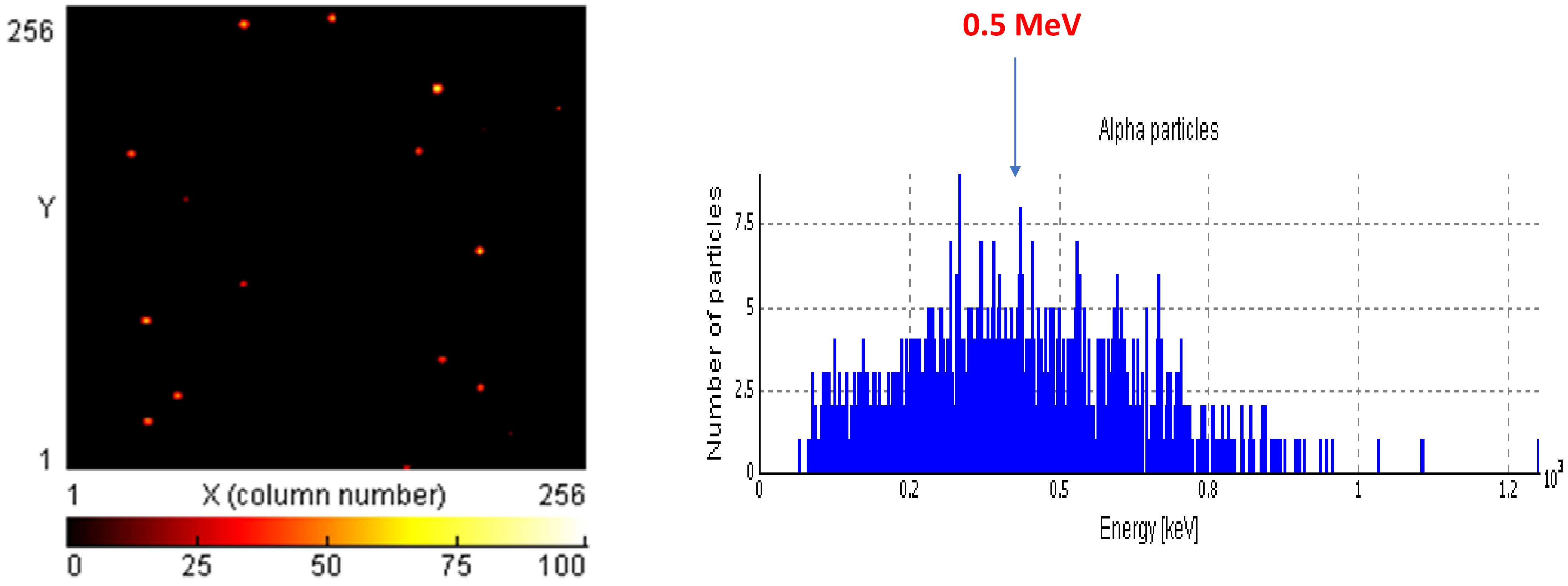


Fig. (18)

Fig. (18) Absorption of alpha particle energy in the air by moving the alpha source away by 2.5 cm

-When the positioner blocks are about 3 cm away, no alpha particles are detected any more.

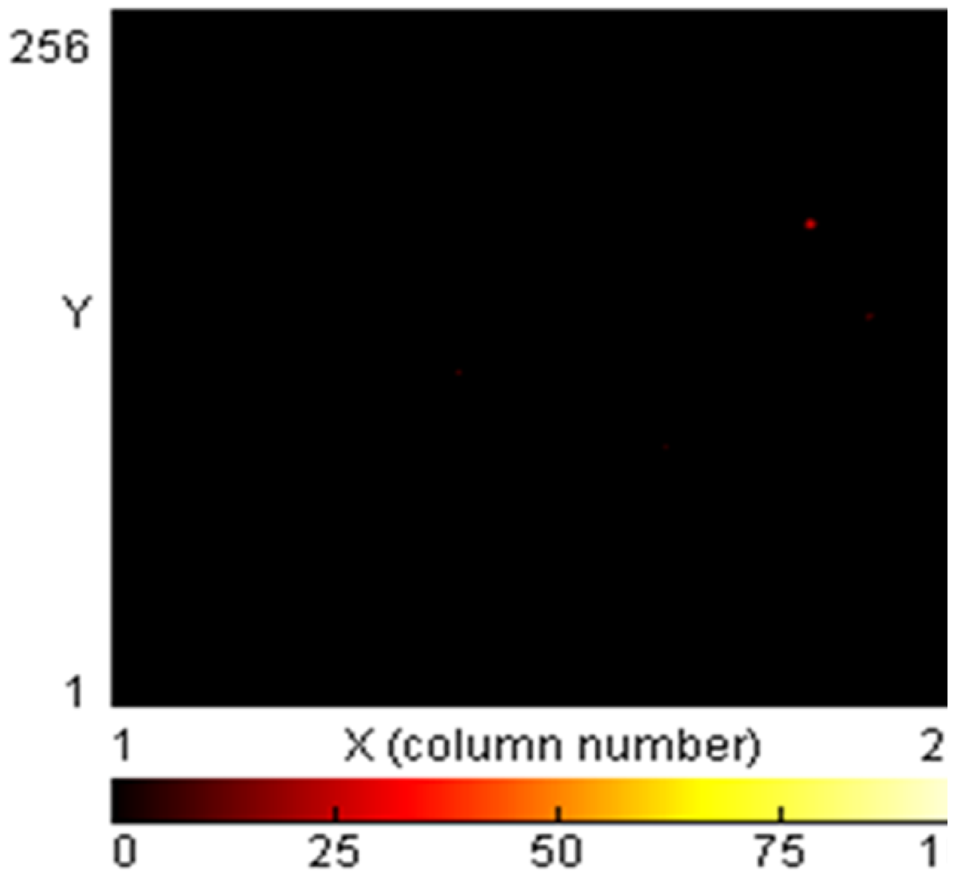


Fig. (19) Maximum of alpha particle range is 3 cm

The Third Part

3.1 Attenuation coefficient

The aim of our work is to determent the attenuation coefficient of **(Cu, Al)** then we can design a shield for any radioactive source.

Experiment equipment:

- BGO scintillation detector
- operating volt 2000V
- Gamma Source Cs137 with energy 661 KeV

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

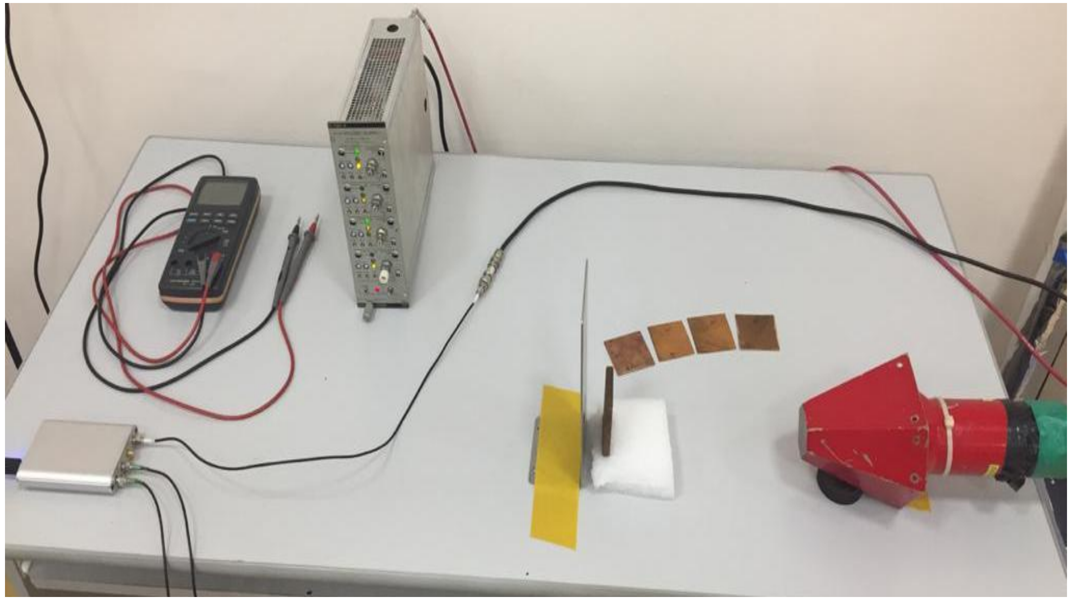


Fig. (20)

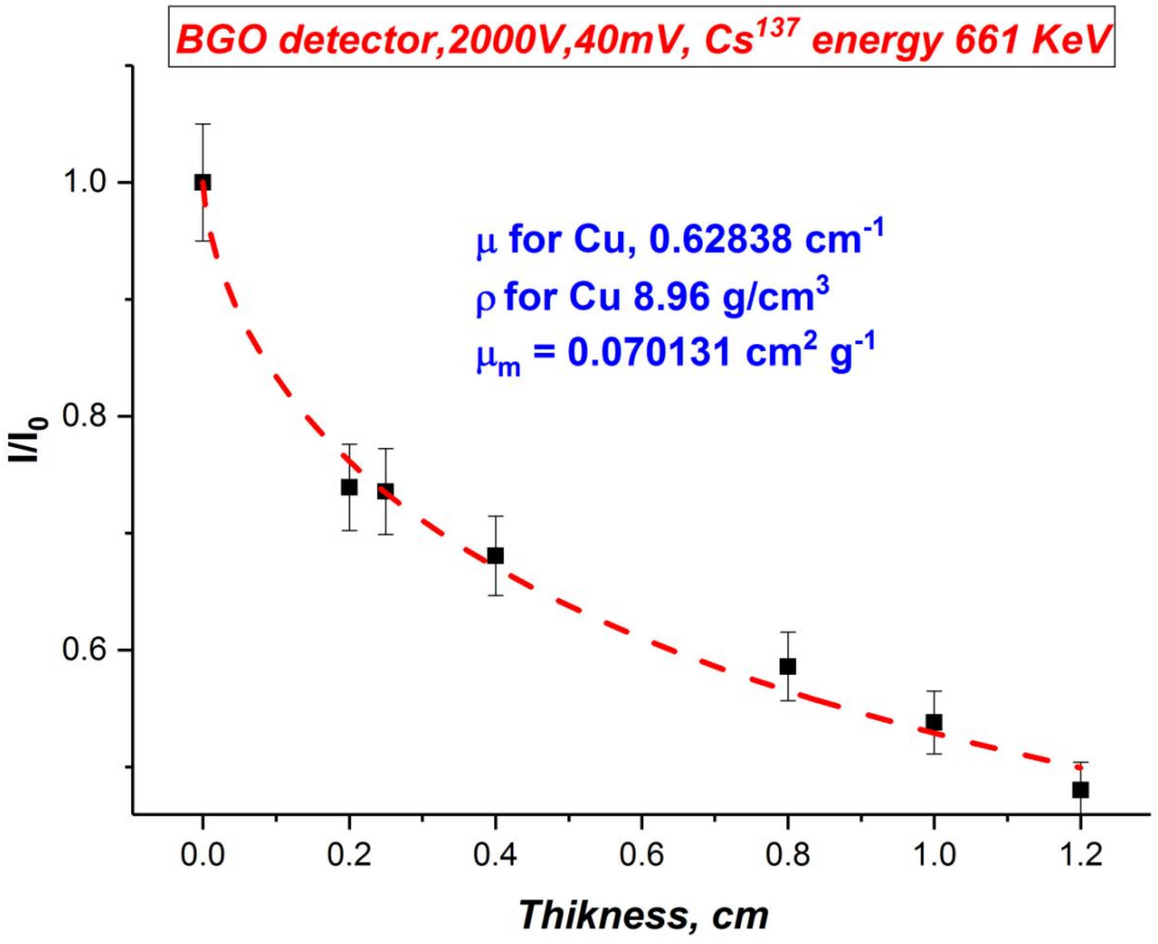


Fig. (21)

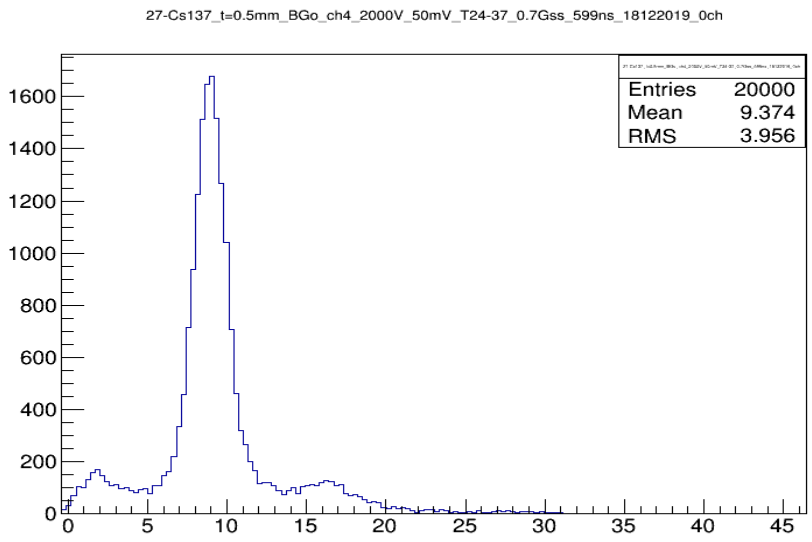


Fig. (22 a)

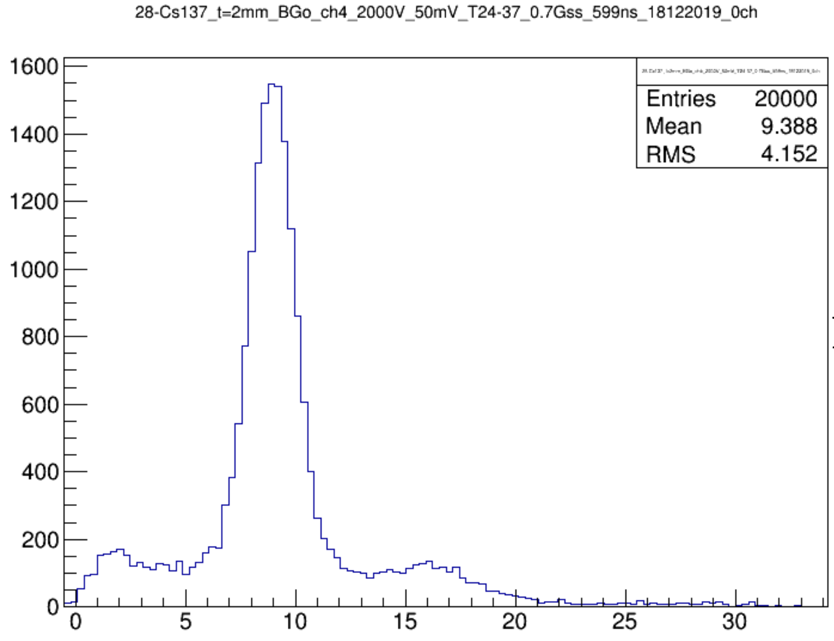


Fig. (22 b)

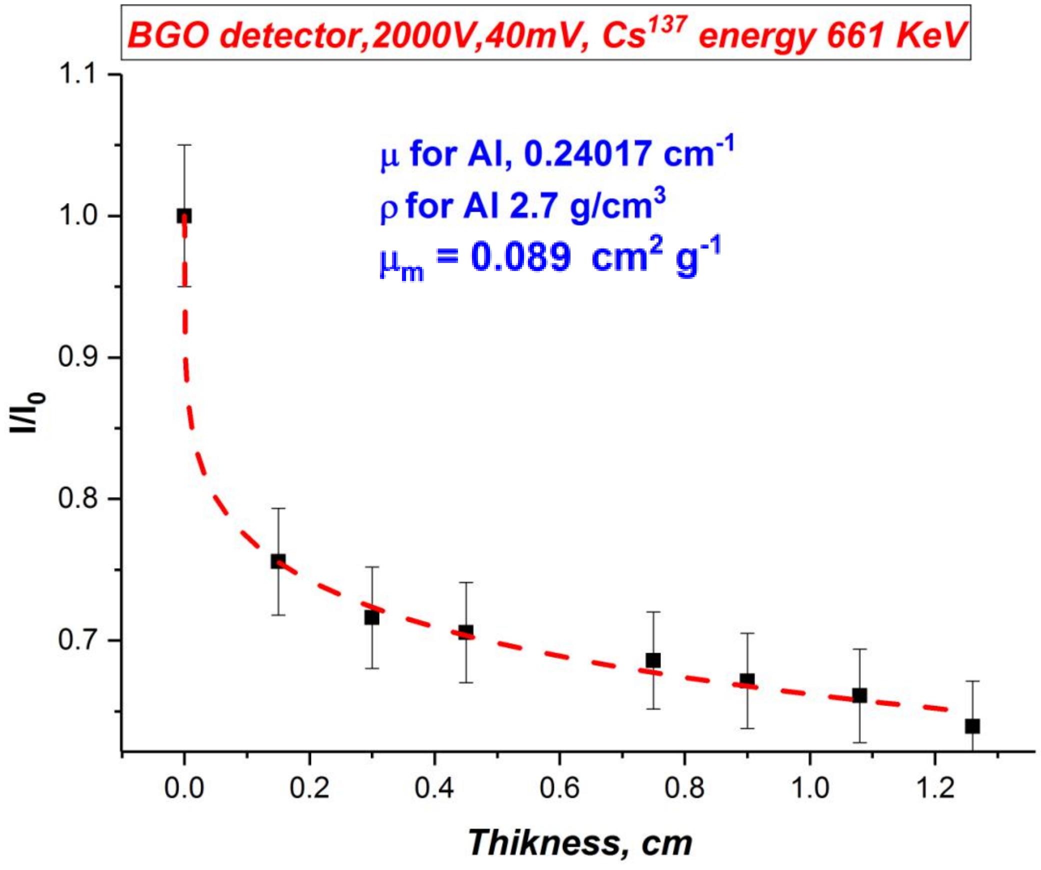


Fig. (23)

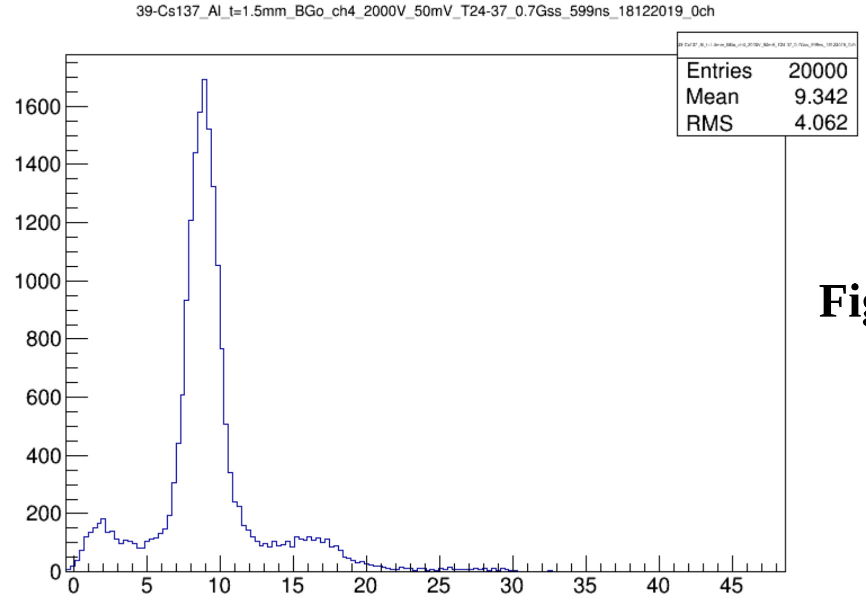


Fig. (24 a)

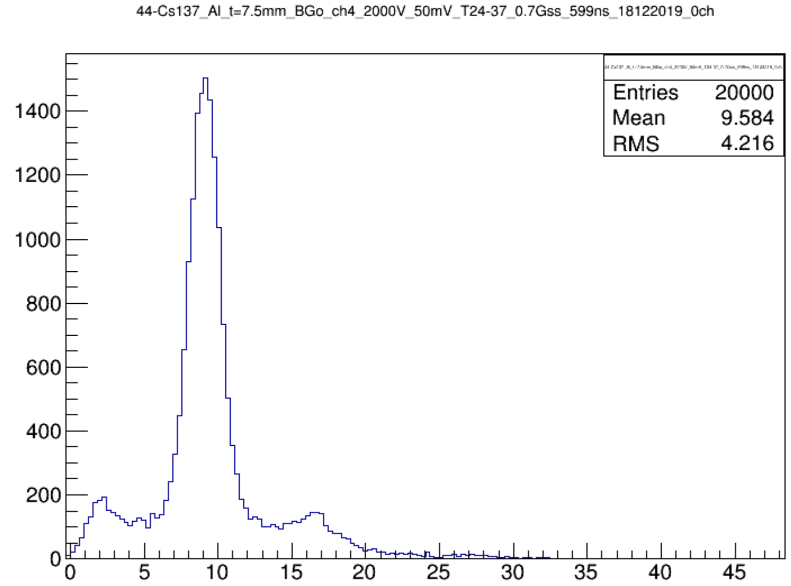


Fig. (24 b)

3.2 Alpha range in Air

The second task of our work is to determine alpha range in air using plastic scintillator detector, applied voltage was 1000 V

We used alpha source Pu239 , the energy of alpha is about 5 MeV.

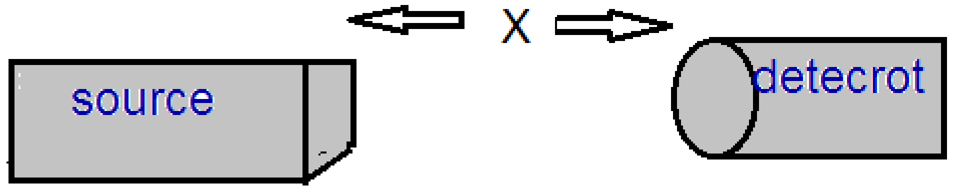
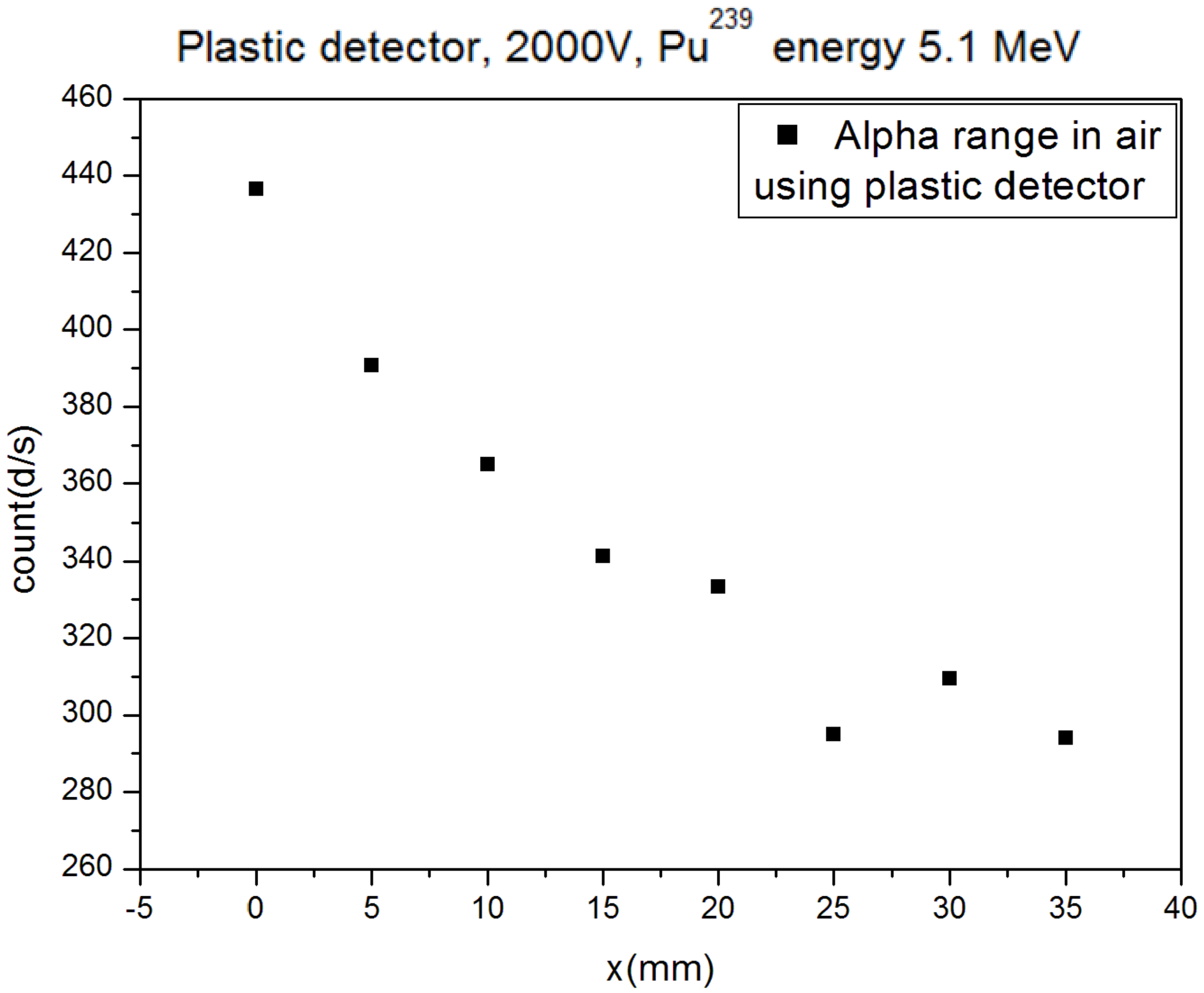


Fig. (25)


Plastic detector, 2000V, Pu 239 energy 5.1 MeV
Alpha range in air using plastic detector
count(d/s)
x(mm)
460
440
420
400
380
360
340
320
300
280
260
-5
0
5
10
15
20
25
30
35
40

R = 3.5 cm

Fig. (27)

Energy spectrum of Alpha

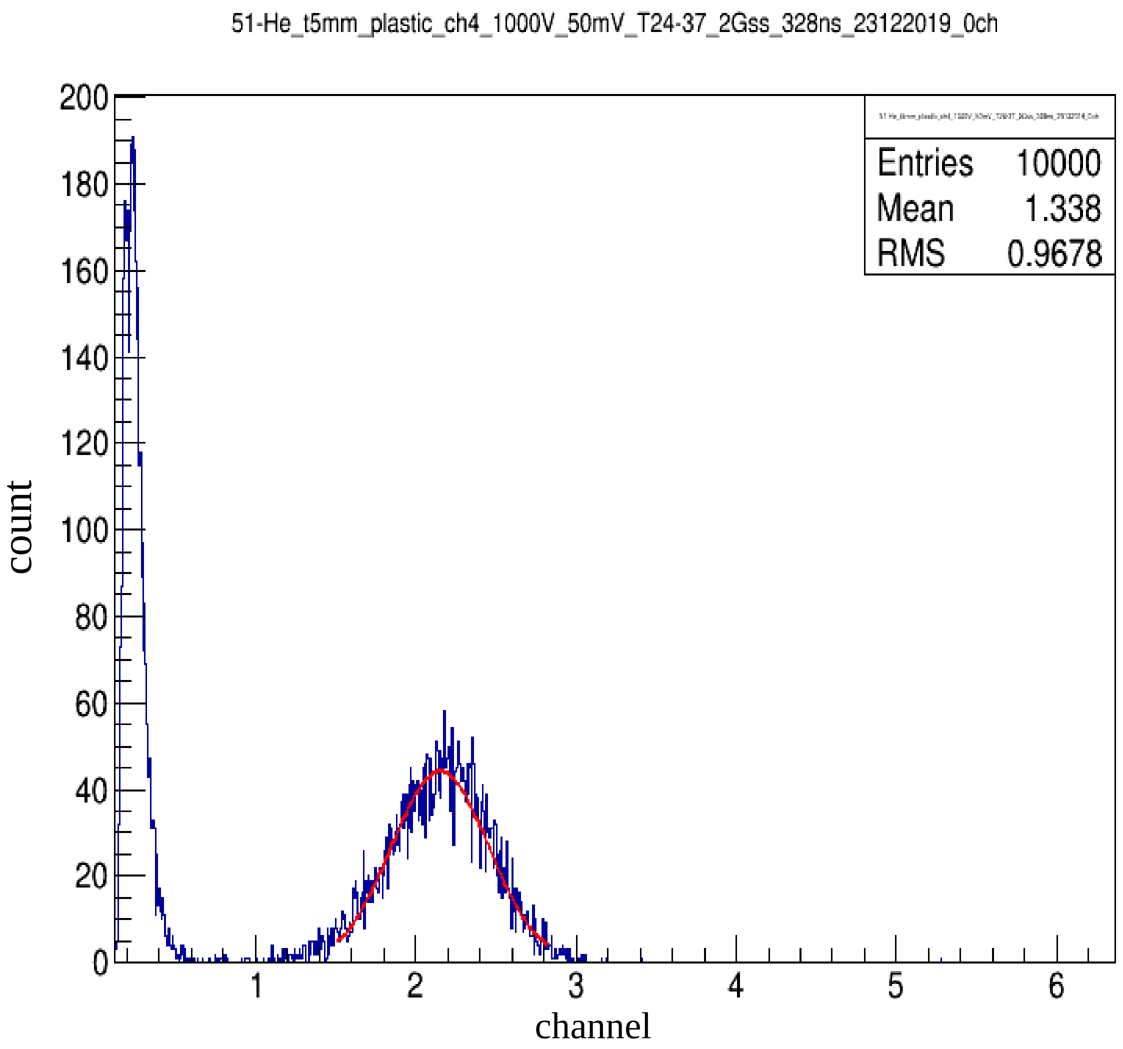


Fig. (26 a)

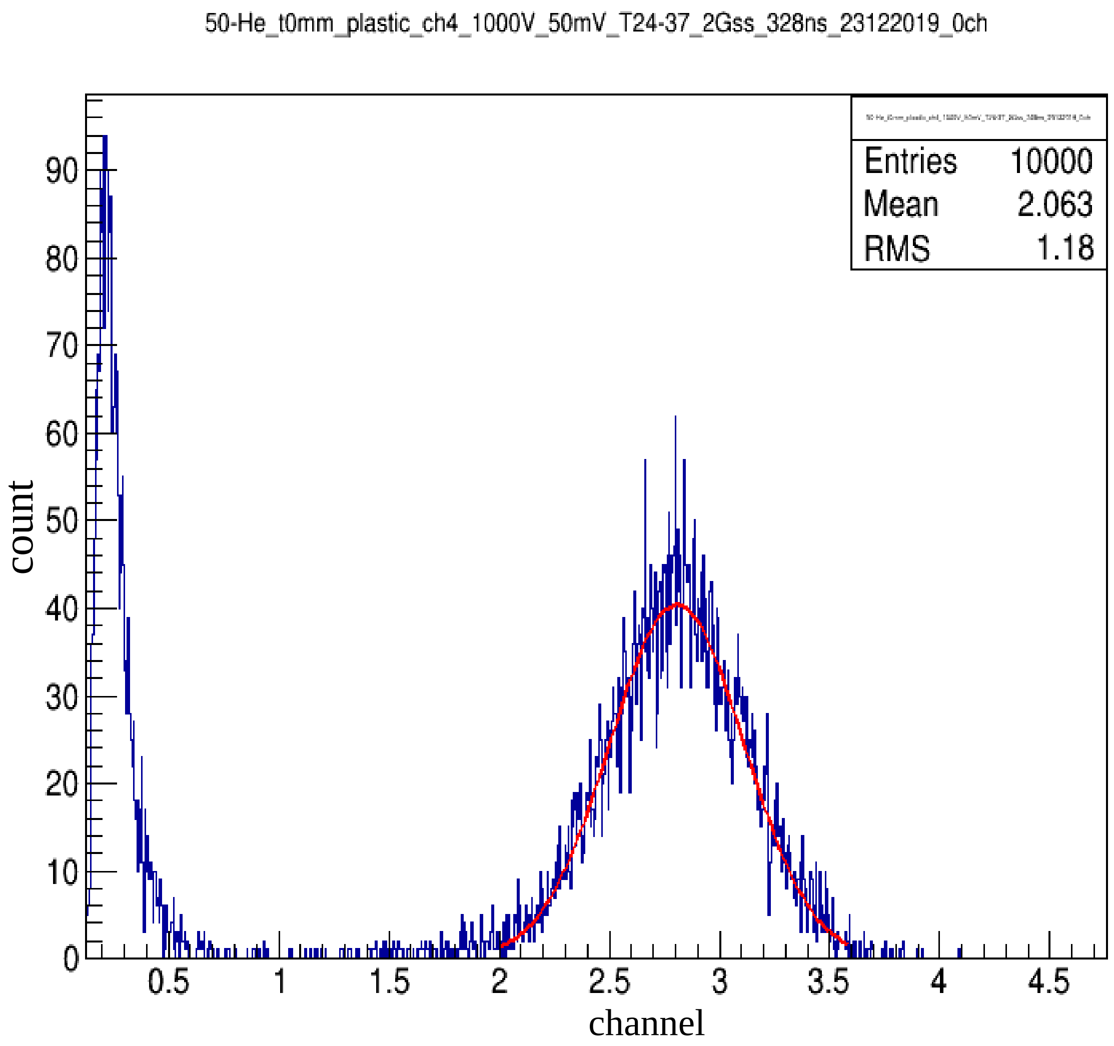


Fig. (26 b)

Alpha Range In Air Using Mont Carlo Simulation SRIM

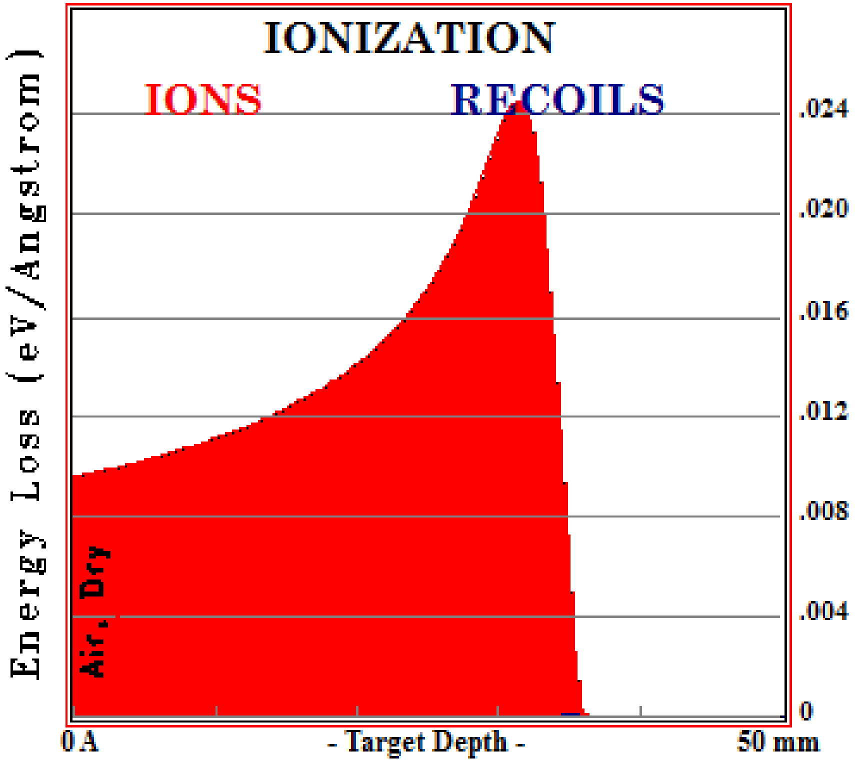


Fig. (28 a)

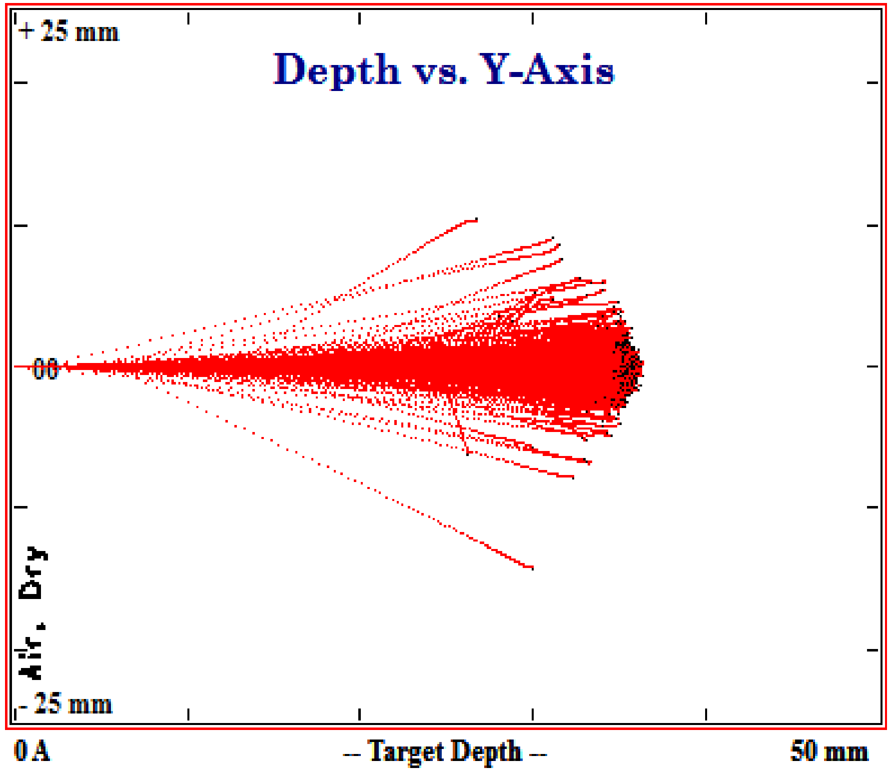


Fig. (28 b)

Energy loss of Alpha in air

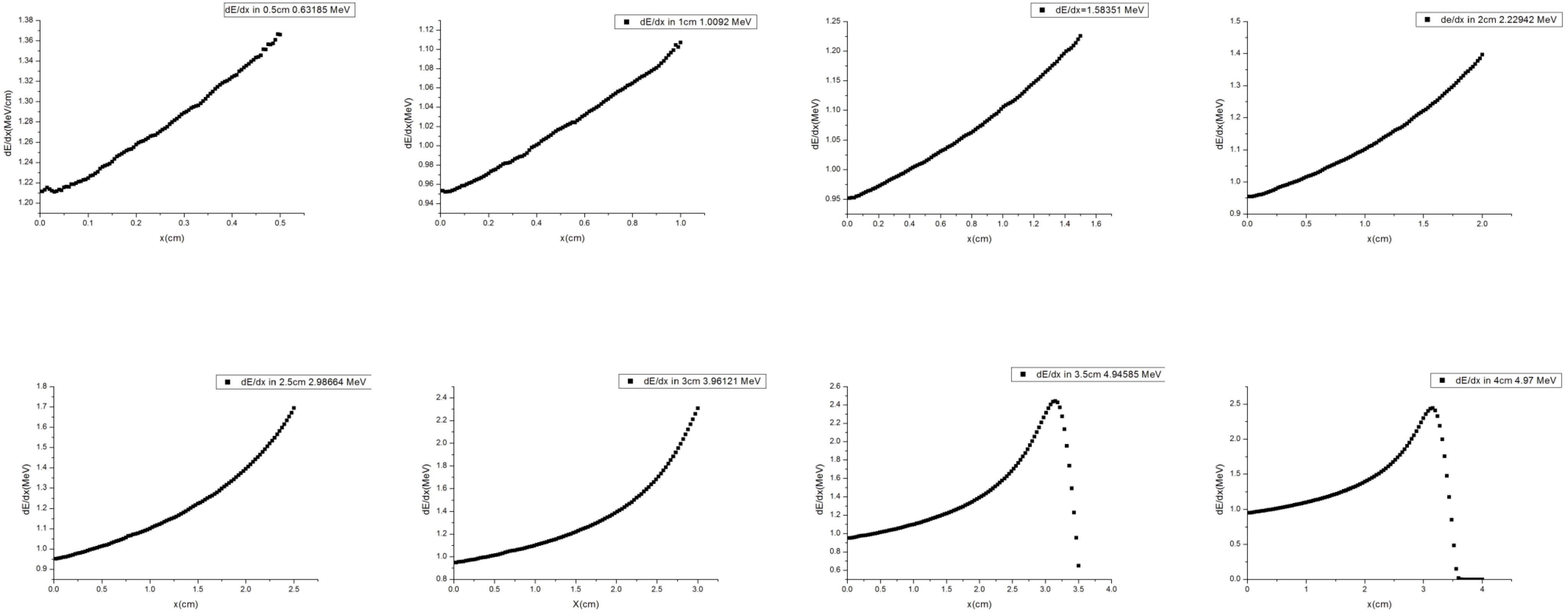


Fig (29)

Outcome

1. Acquiring a sound basis in radiation protection and the safety of radiation sources.
2. Providing the necessary practical skills and basic tools for occupational and the safe use of radiation sources.
3. Implementation of the safety principle designed to minimize radiation doses and releases of radioactive materials (ALARA).
4. Evaluation of exposure, absorbed, equivalent, and effective doses for each type of radiation.
5. Studying the response of scintillation and pixel detectors.
6. Using DRS software to analysis spectra obtained from NaI(TI), BGO, and Plastic detectors.
7. Using PixelMan software to analysis spectra obtained from alpha Spectroscopy.
8. Using simulation software (SRIM, ROOT).


Thank You!