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Radiation Protection and the Safety of the Radiation Sources INTEREST - International Remote Student Training at JINR Wave 5

FINAL REPORT ON THE INTEREST PROGRAMME

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Radiation Protection and the Safety of the Radiation Sources

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Participation period:
27 September – 05 November, Wave 5

Natural background radiation.

- Radioactivity was not invented by man however he discovered them. Radiation has been part of nature since the origin of the universe. This radiation is called natural background radiation. The quantity of radiation does differ from place to place, but nobody can avoid it completely.

- Sources of natural background radiation are the following: From outer space, From the earth itself, From the air we inhale and From the human body.

A picture showing sources of natural background radiation.

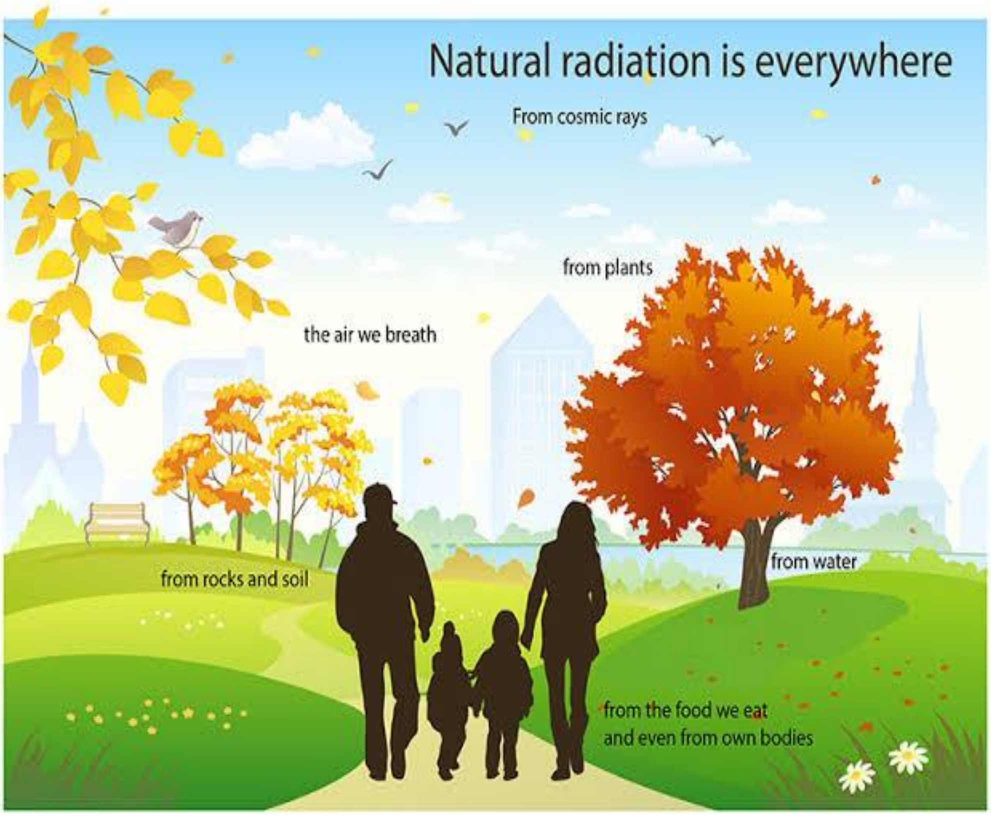

Figure 1.

- **Man-made radiation sources** consists of X-rays and radioactive sources such as Uranium, Cesium-137 and strontium-90.

- **Man-made radiation sources** can be used for medical uses, industrial uses, power generation and articles for everyday use (e.g smoke detectors).

The hazards of radiation and the need for protection measures.

- Depending on how it is used and controlled, radiation has advantages and disadvantages. Ionizing radiation is potentially harmful because it can harm your body without you being aware of it, for this reason protection against radiation are necessary.

- We cannot see, feel, smell, taste or hear radiation and therefore we are not always aware of the possible danger however we should know and observe the safety measures. There are strict standards and controls so that the amount of radiation a person receive over and above natural background is as little as possible. For example radiation dose limits that may not be exceeded are laid down.

- The radiation risks to people and the environment that may arise from the use of radiation and radioactive material must be assessed and must be controlled by means of the application of standards safety.

- The system of radiation protection and safety aim is to protect people and the environment from harmful effects of ionizing radiation.

Radiation Dosimetry.

- **Radiation Dosimetry** attempts to quantitatively relate absorbed radiation dose to biological, chemical and/or physical changes that the radiation would produce in a target.

- In radiation dosimetry and radiation protection in particular, two international organisations are active in relation to Quantities and units namely**: 1. ICRU(International Commission on Radiation units)** which mainly works with **physical aspects** of dosimetry,**2. ICRP(International Commission on Radiological Protection)** mainly works with assessments and quantification of them **biological aspects** of radiation and provides recommendations and guidance on all aspects of radiation protection against ionising radiation.

A picture showing physical, protection and operational quantities.

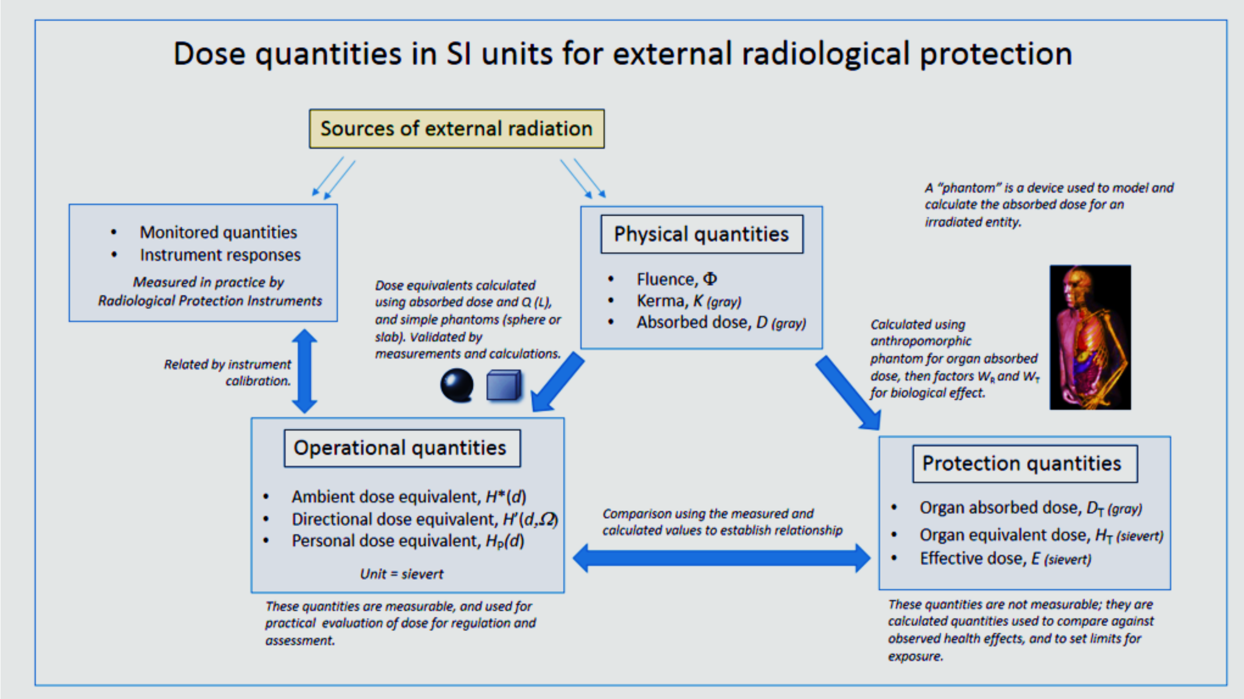

Figure 2.

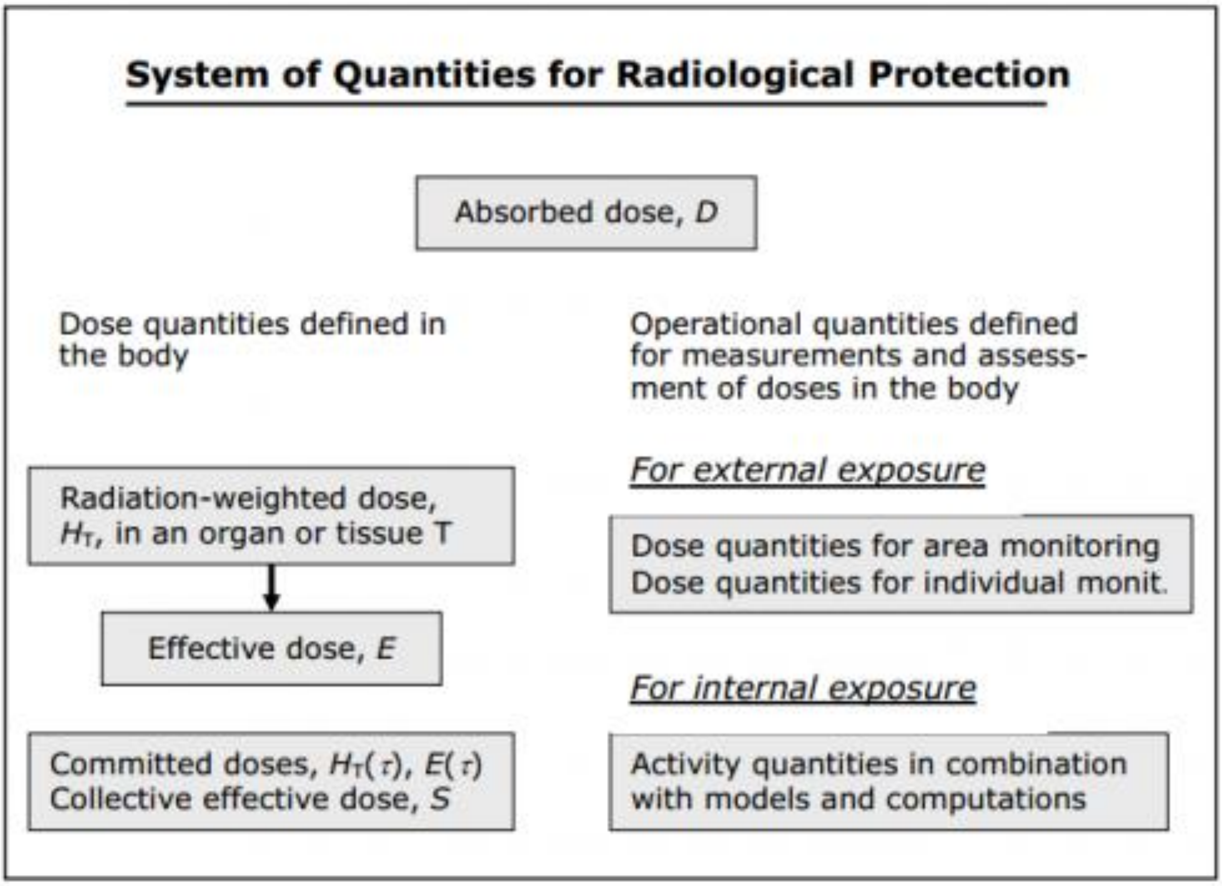

Figure 3.

A Graphic showing relationship of SI radiation dose units.

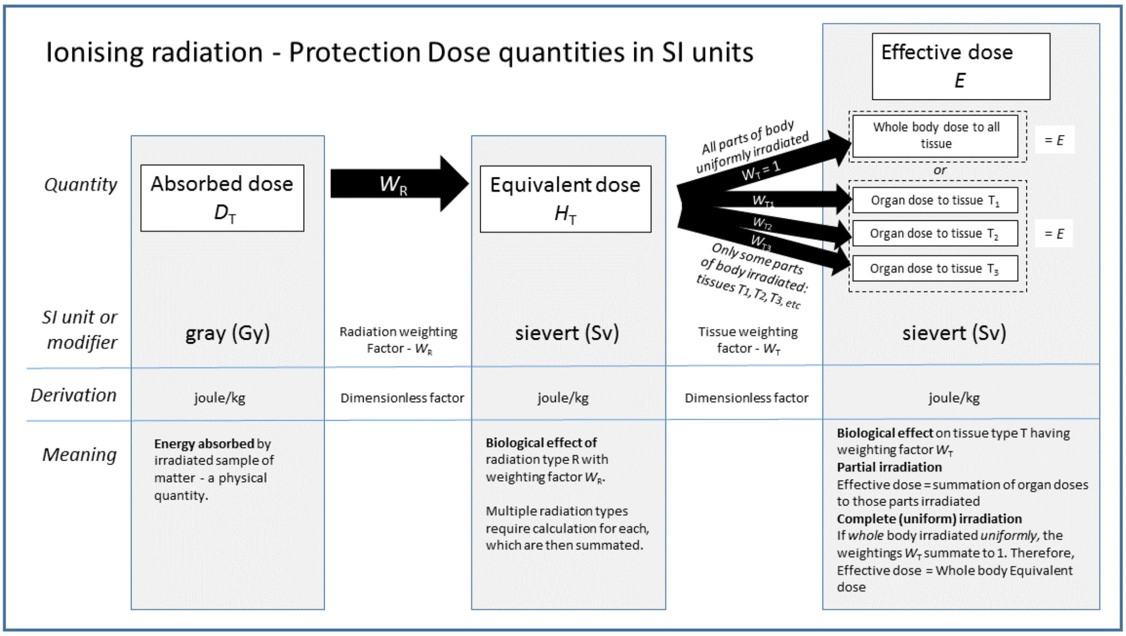

Figure 4.

- **Absorbed dose** is the energy absorbed per unit mass due to any kind of ionizing radiation in any target (Gray), it is mostly used for beta radiation.

- **Exposure** is defined for gamma and X-rays in terms of ionization they produce in air. The unit of exposure is Roentgen(R)

- **Equivalent dose** it has long been recognized that different radiation affects the biological tissue differently, it is measured Sieverts(sv).

A graphic of radiation quantities and units.

Quantity	Symbol	SI Unit
Exposure	**R**	Roentgen(R)
Absorbed dose	**D**	Gray(Gy)
Effective dose	**E**	Sieverts(Sv)
Equivalent dose	**H**	Sieverts(Sv)

Scintillation detectors experimental setup

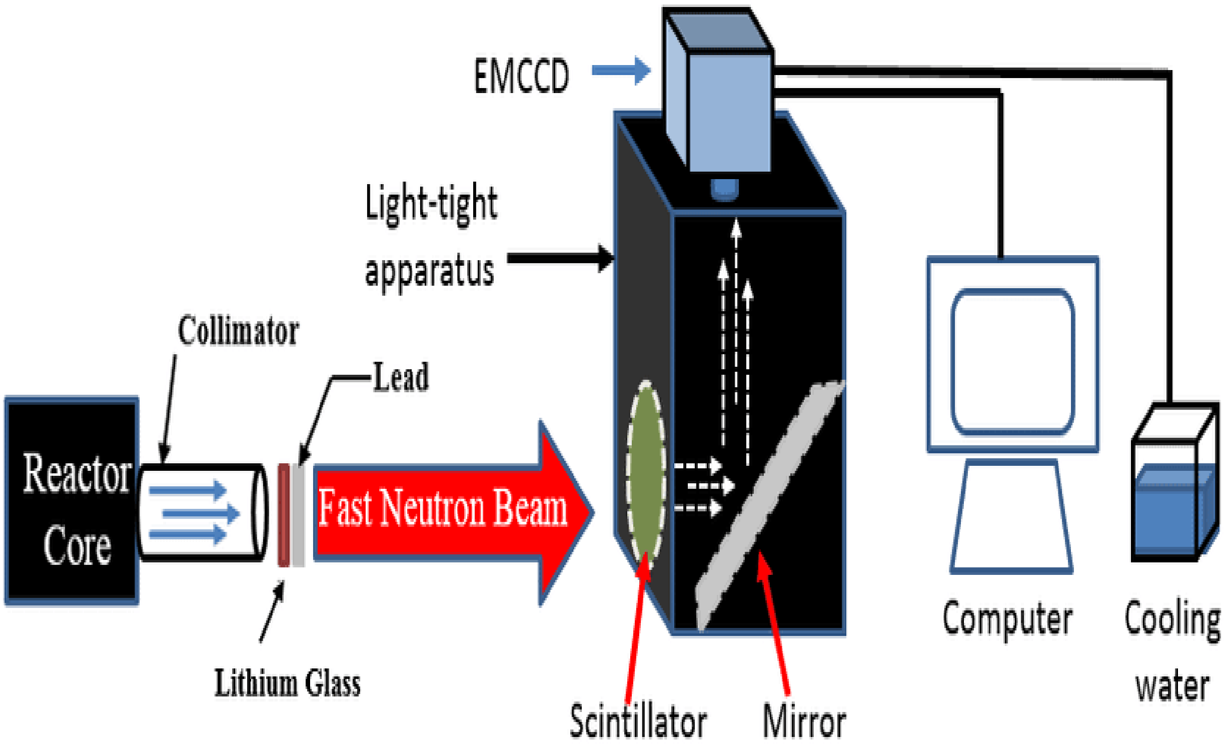

Figure 5

Task 1.1 The relation between the resolution and applied voltage for BGO detector.

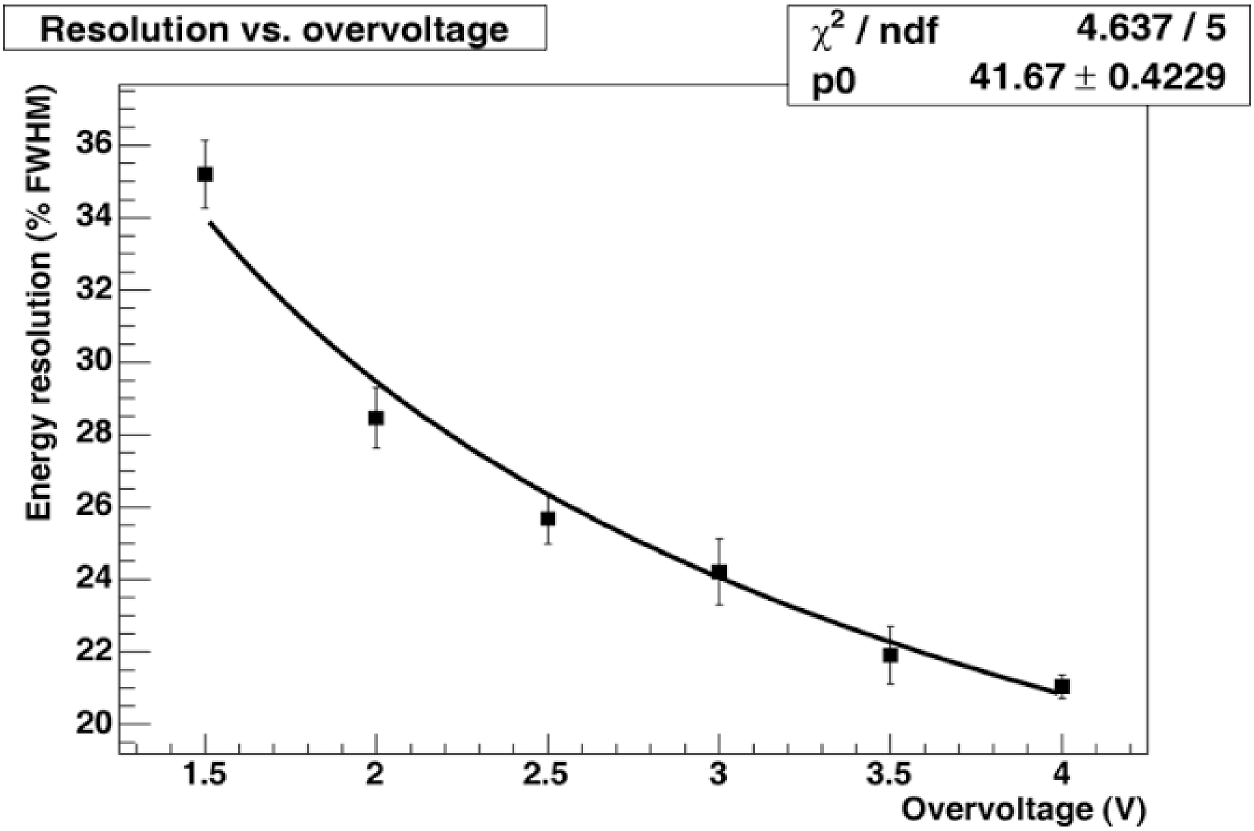

Figure 6. (relation between resolution and applied voltage)

Task 1.2 Energy Clibration for BGO

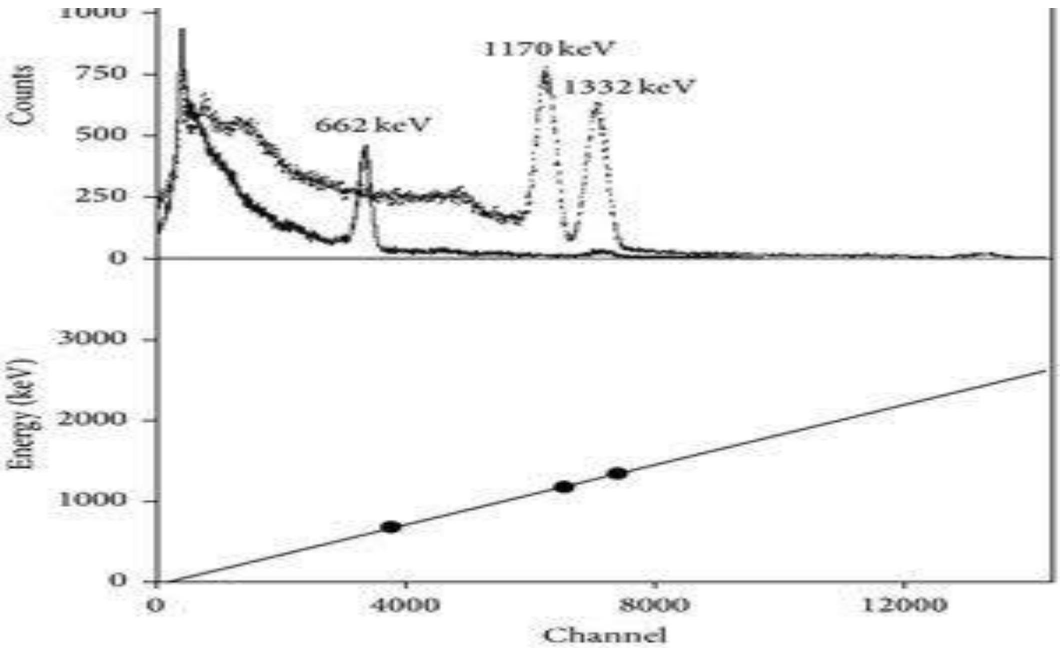

Figure7(Cs-137 and Co-60 spectrum from measurements with NaI detector at 2000 V)

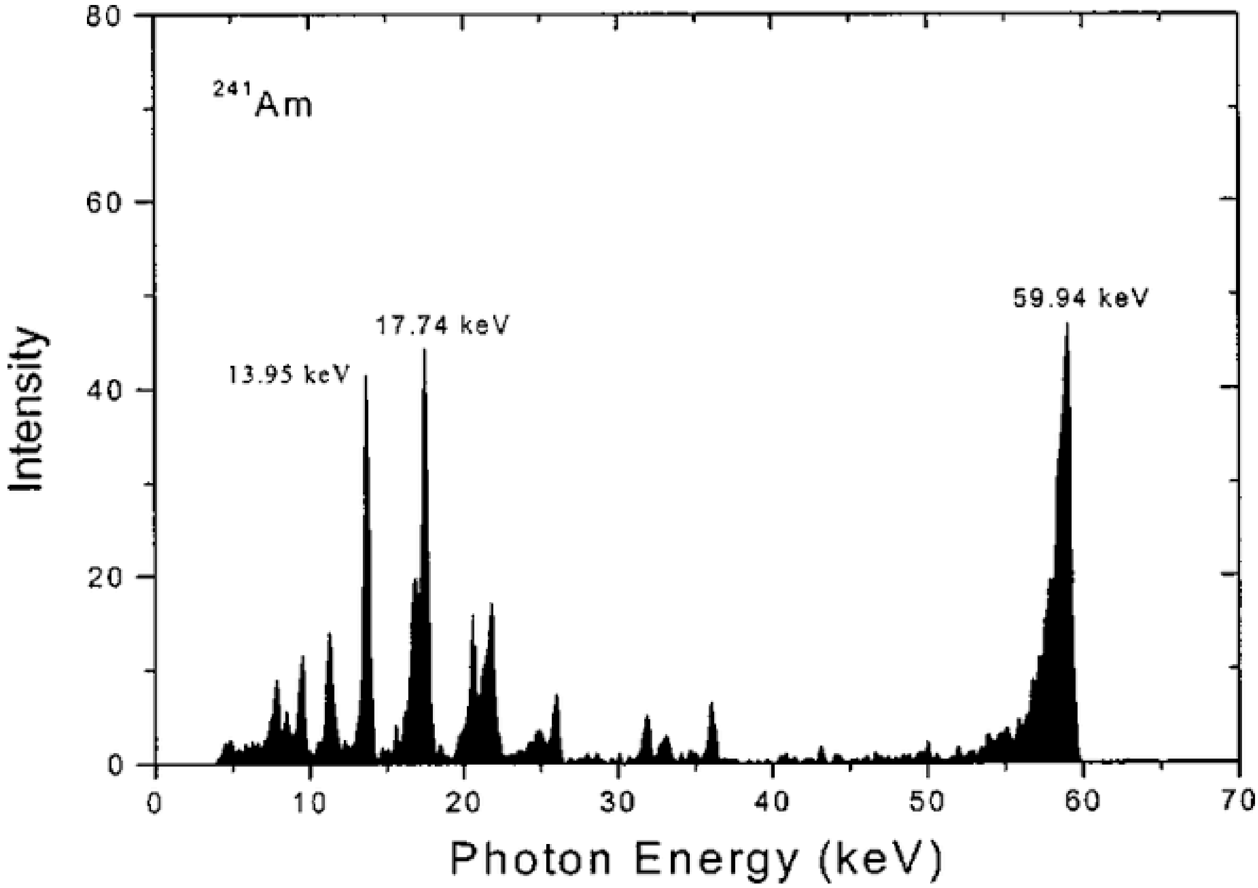

Figure 8(Energy calibration function)

Task 2.1 The relation between the resolution and applied voltage for NaI detector.

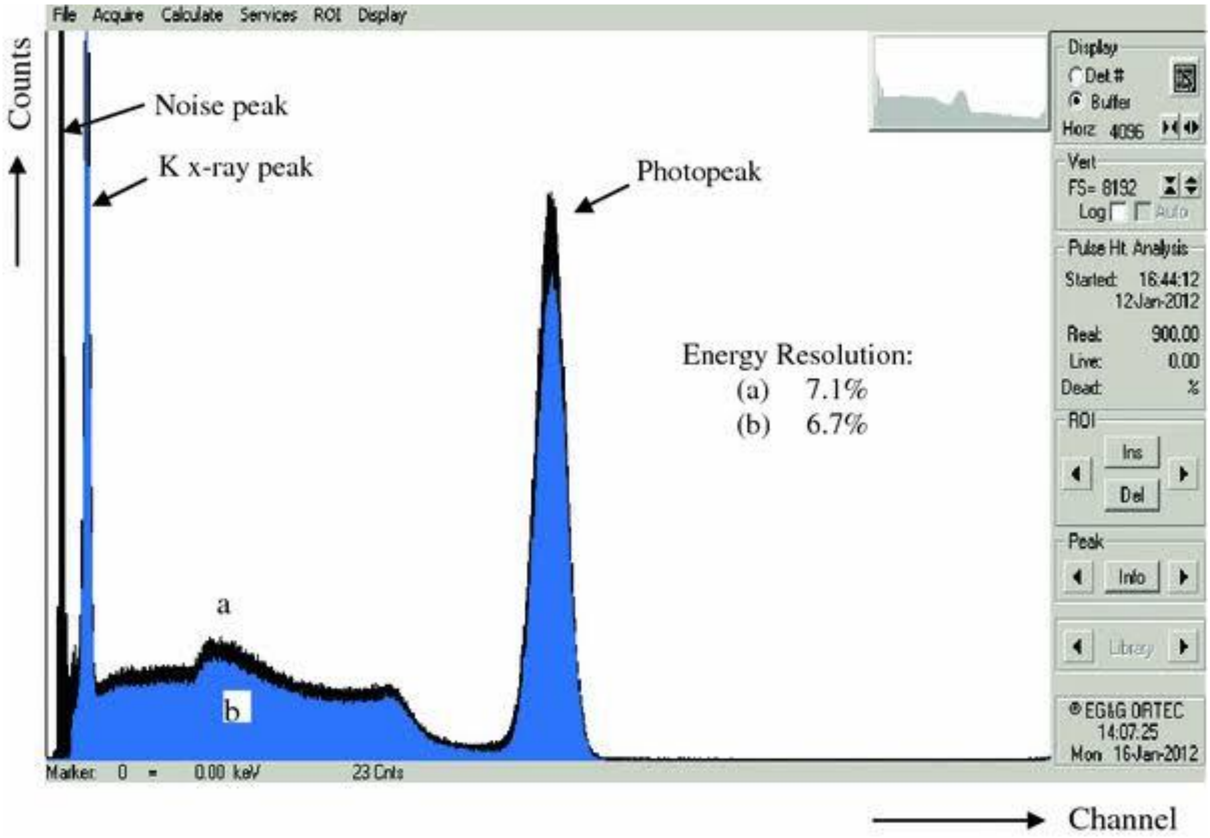

Figure 9.(Cs-137 and Co-60 spectrum from measurements with NaI detector at 2000 V)

Task 2.2 Energy calibration for NaI.

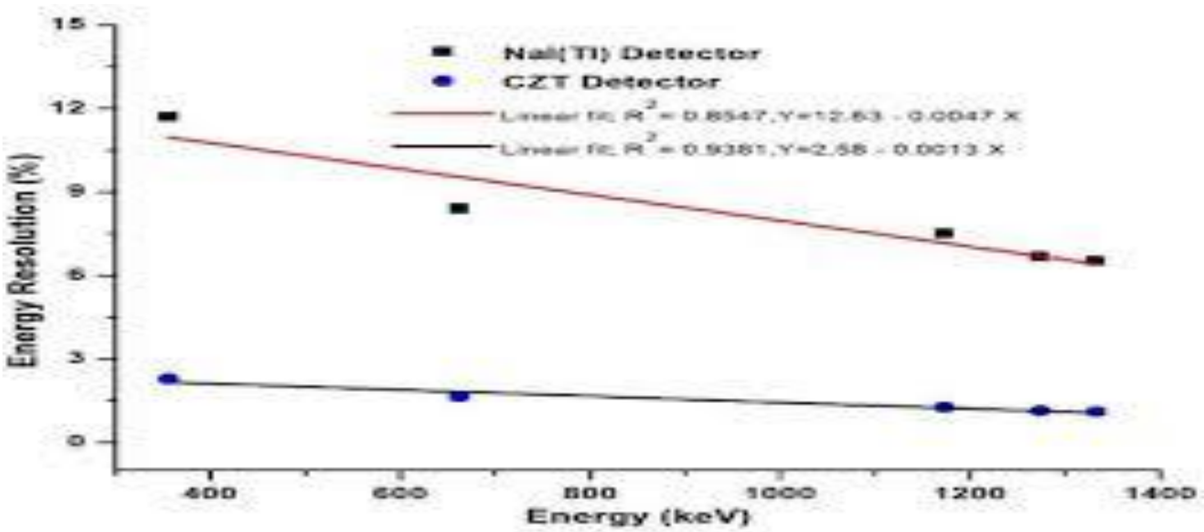

Figure 10 (Energy calibration function).

Task 2.3 Identification of unknown sources.

- Identify the spectrum of the unknown source.
- Identify the different energy peaks.
- We should find the best fit and also find the mean.
- From energy calibration we can determine energy peak of unknown source by using equation from calibration of NaI detector.

Task 3 Attenuation Coefficient

- Attenuation coefficient characterizes how easily a volume of material can be penetrated by a beam of light, sound, particles or matter.
- A coefficient value that is large represents a beam becoming attenuated as it passes through a given medium, while a small value represents that the medium had effect on loss. The SI unit is m^{-1} .
- Equation of attenuation coefficient is $I = I_{O}e^{-\mu x}$

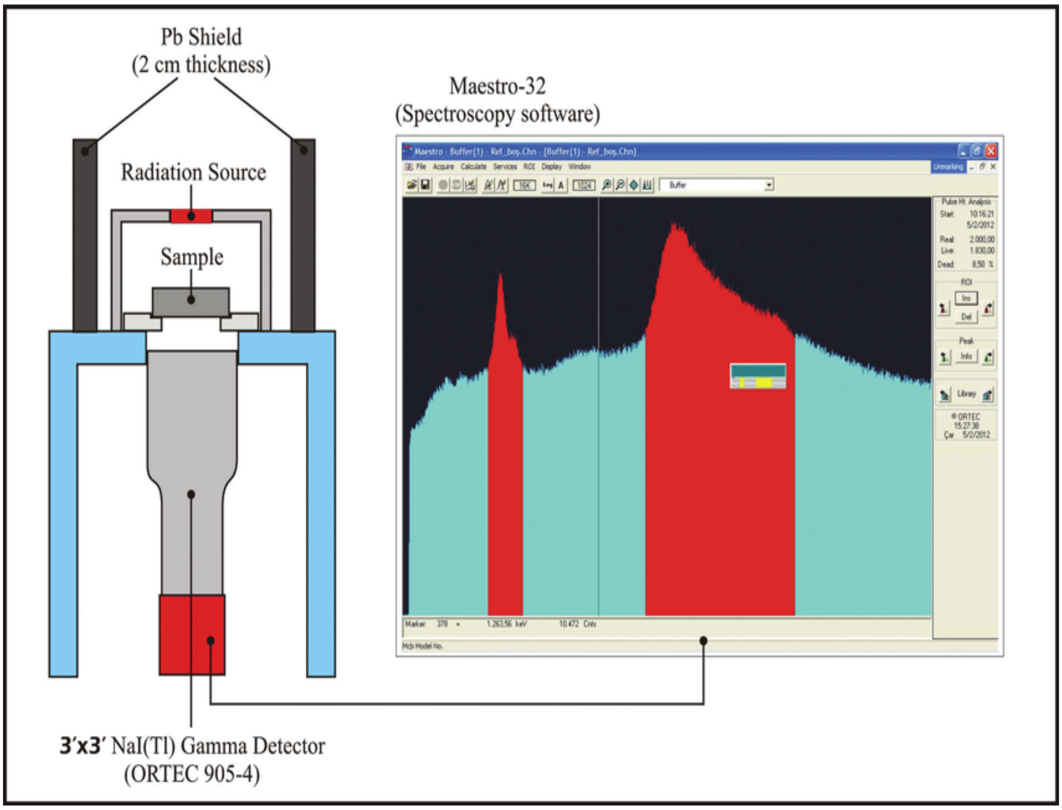

Figure 11(Experimental set-up for determining the attenuation coefficient)

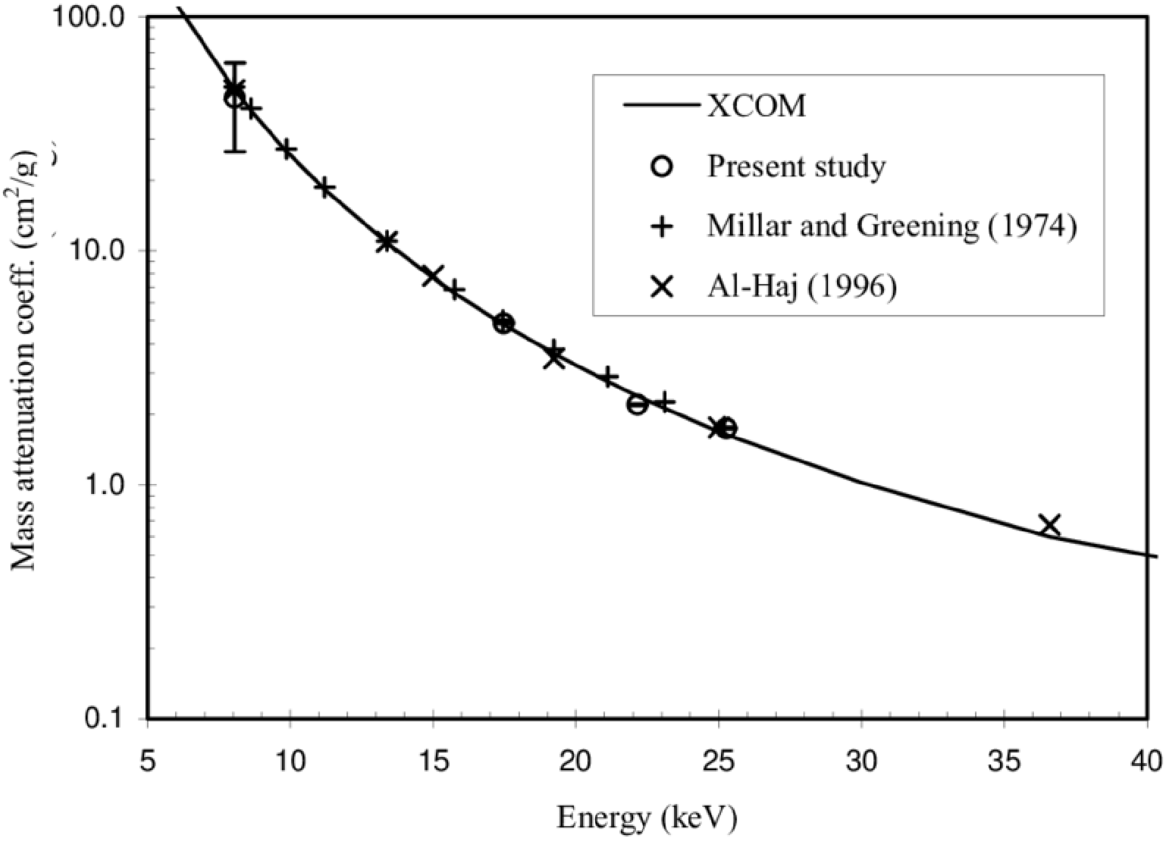

Figure 12(Determination of attenuation coefficient for Al)

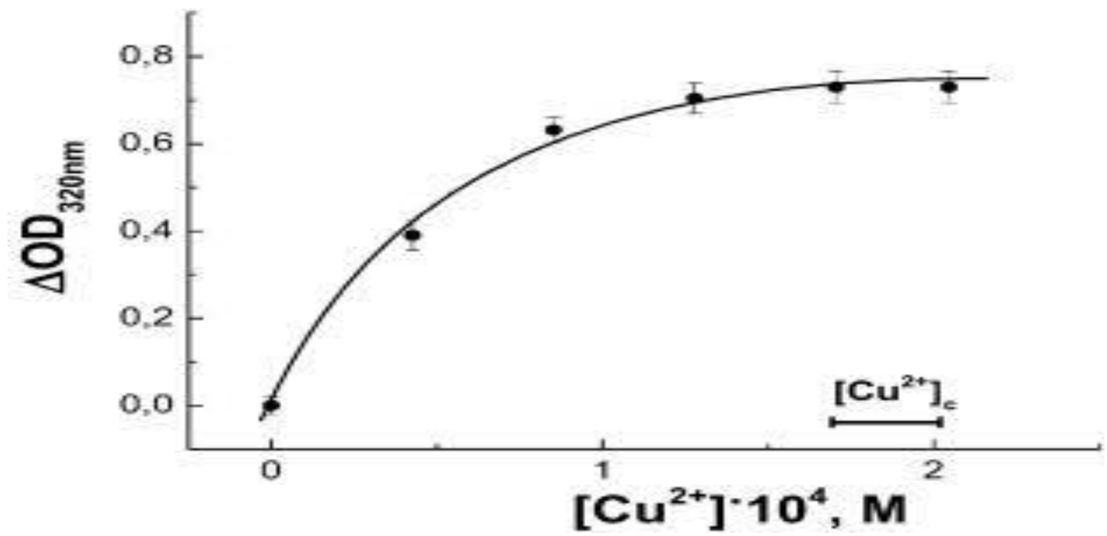

Figure 13(Determination of attenuation coefficient for Cu)

Task 3. Alpha range in air

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

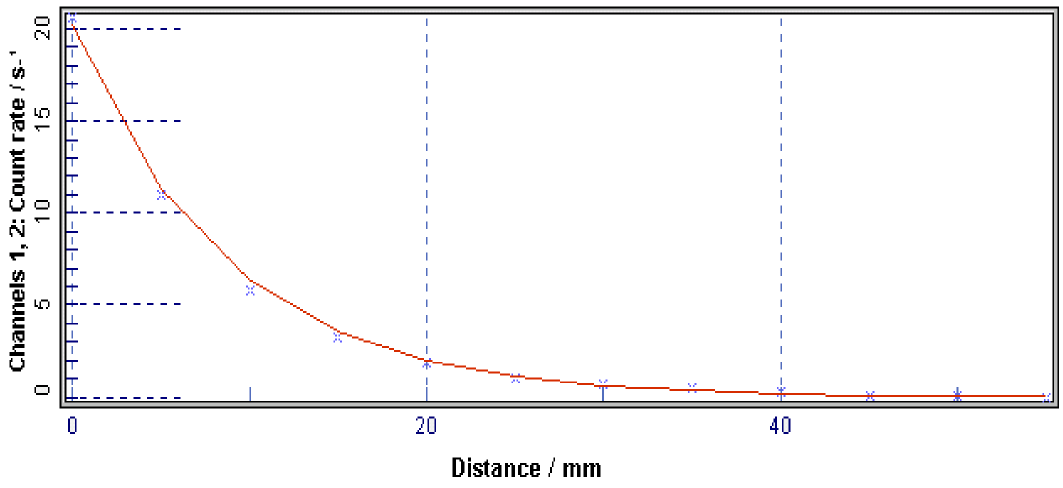

Figure 14(The range of alpha particles)

Task 4. Pixel Detectors.

- Pixel detectors are a type of ionizing radiation detector consisting of an array of diodes based on semiconductor technology and their associated electronics.
- They have paved the way for high resolution, high rate and high radiation devices indispensable from particle tracking and imaging experiments.

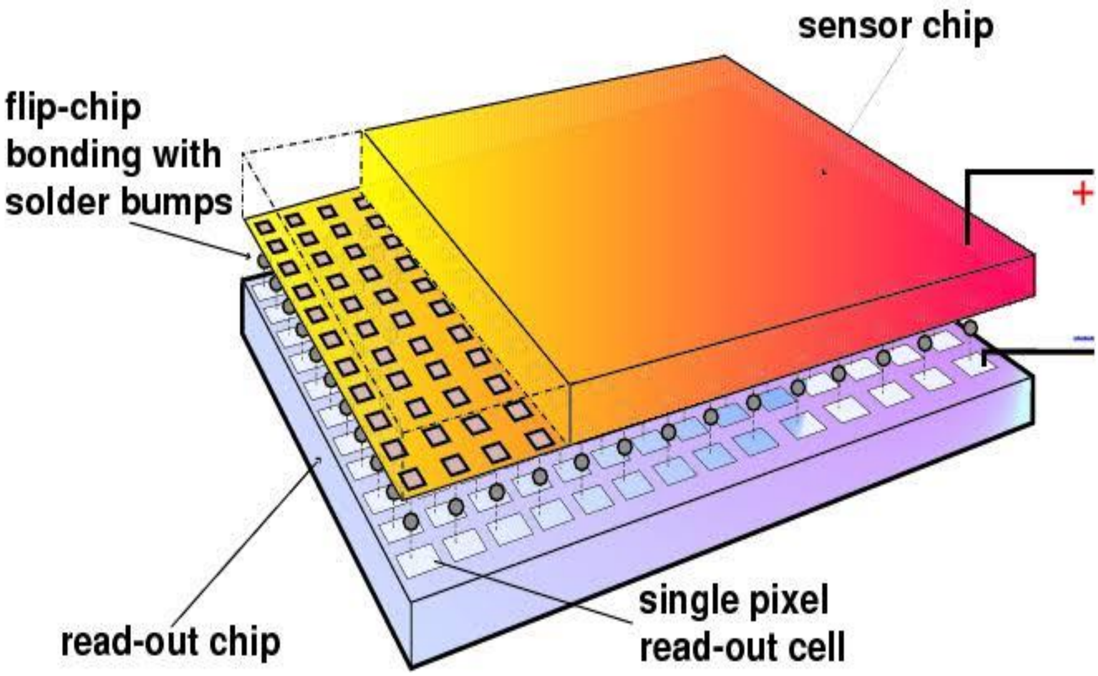

Figure 15(Pixel detectors)

Conclusion

- Gaining more knowledge about radioactivity, radiation sources, detection of radiation and protection and safety for radiation sources.
- Limit dose and recommended radiation protection protocol from ICRP,ICRU etc.
- Radioactivity and natural occurring radioactive materials NORM.
- How to do energy calibration of some scintillation detectors by using standard sources.
- Identify of unknown source by using energy calibration curve.
- Calculating Resolution of different scintillation detectors.
- Determining alpha range in air using Pixel and plastic detectors.
- Determining Attenuation coefficient for different materials.

References

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