# Study on Measurements of Gamma Radiations by G-M Sensor For Mn-54, Co-60, Co-57 And Cd-109 Gamma Sources

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**Abstract**: *We measured gammed radiations from gamma sources such as Manganese (Mn-54), Cobalt (Co-60), Co-57 and Cd-109 by using G-M sensor. The gamma radiations were measured at various distances from G-M sensor. It is observed that the smaller the distance from gamma source, the larger the number of gamma radiation is. We also measured the number of gamma radiations by placing aluminum sheets between gamma source and G-M sensor. It is seen that the gamma radiations are decreased with increasing aluminum sheets. From these data, we calculated the statistical error of G-M sensor for various sources. The activities of various sources are calculated from radioactive decay law for present time. The calculated present activities in May 2019 are 0.00775 µCi for Mn-54, 0.54406 µCi for Co-60, 0.00375 µCi for Co-57 and 0.04307 µCi for Cd-109. Therefore, we can know the present activities for those sources.*

**Keywords**: G-M sensor, gamma sources, statistical error, activity

## 1. INTRODUCTION

The Geiger counter is an instrument used for measuring ionizing radiation widely used in such applications as radiological protection, experimental physics and the nuclear industry. It detects ionizing radiation such as alpha particles, beta particles and gamma rays using the ionizing effect produced in a Geiger –Muller tube. It is perhaps one of the world's best-known radiation detection instruments.

The original detection principle was discovered in 1908, but it was not until the development of the Geiger-Muller tube in 1928 that the Geiger-Muller counter become a practical instrument. A Geiger counter consists of a Geiger-Muller tube, the sensing element which detects the radiation, and the processing electronics, which displays the result. The Geiger-Muller tube is filled with an inert gas such as helium, neon, or argon at low pressure, to which a high voltage is applied.

The G-M sensor is used for the study on radioactivity experiment; it can count the active particles that pass through the probe. The G-M sensor is mainly used to measure the intensity of $\gamma - ray$ and $\beta - ray$; it also can be used for the experiment on measuring X-ray. Since the wall of G-M counter tube is made of a very thin precision material, and easy to be damaged, it must be prevented from foreign matters into the tube when it is used.

The core component of the G-M sensor is the G-M counter tube. It is sealed, with low pressure air inside. The circuit of the sensor provides high voltage for G-M tube, and then it will form a high electric field in G-M tube; when the incident particle goes into the G-M **2.**

## 2. MEASUREMENT OF G-M SENSOR

Any hit or knock at the probe of the G-M sensor in use, that may make it broken or destroyed. The radiation source used in school is very weak, but it still needs to pay quite attention to it when using. The radiation source can be only handled by clamp or other fixers. Do not put the radiation source at a place near yourself or other people. After completing the experiment, clean your hands immediately. The radiation source must be kept safely, locked well, and with the identification label.

Monitor counts/interval (rate) as different thicknesses of a particular type of shielding are placed between the Geiger-Muller tube of the radiation monitor and a beta or gamma source. We measured the number of gamma radiation by placing aluminum sheets between source and vernier radiation monitor. It is measured radiation of common radioactive materials. Monitor variation in background radiation at different elevations. We monitor radioactivity in the environment over long periods of time and counts per interval (rate) from a beta or gamma radiation source as a function of the distance between the source and the radiation monitor.

## 3. CALCULATION OF STATISTICAL ERRORS AND ACTIVITIES

There are eight gamma sources at Department of Physics, University of Research Centre, Monywa. These gamma sources are Mn- 54, Co- 60, Co- 57, Cd-109, Ba-133, Unknown, Na- 22 and Cs-137 sources as shown in Figure 1. Among them, we choose sources which are Mn- 54, Co- 60, Co- 57 and Cd- 109 sources as shown in figure 2. Figure 3 shows Measurement of gamma radiations by G- M sensor at Department of Physics, University of Research Centre, Monywa University.

**Figure 1. Various gamma sources at Department of Physics, University of Research Centre, Monywa**


**Figure 2. Manganese – 54 , Cobalt – 60, Cobalt – 57 and Cadmium – 109 gamma sources**

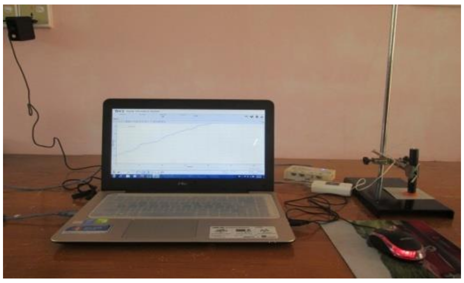

**Figure 3. Measurement of gamma radiations by G-M sensor at Department of Physics, University of Research Centre, Monywa**

## 4. RESULTS AND DISCUSSION

We measured gamma radiations by G-M sensor from those sources. Data were measured with the running intervals set at 60 seconds. It is measured ten times. The results are shown in table 1, 2, 3 and 4. We calculated the statistical error from those data for various sources. The activities of sources are calculated from the data of sources. It is observed that we can know the activity of sources at present and dead time of sources. The results are shown in below.

**Table 1.The number of counts of Mn-54 gamma source for G-M sensor**

| Sr: | $n_i$ | $n_i - \bar{n}$ | $(n_i - \bar{n})^2$ |
|---|---|---|---|
| 1 | 59 | 5.2 | 27.04 |
| 2 | 68 | 14.2 | 201.64 |
| 3 | 52 | -1.8 | 3.24 |
| 4 | 44 | -9.8 | 96.04 |
| 5 | 54 | 0.2 | 0.04 |
| 6 | 70 | 16.2 | 262.44 |
| 7 | 45 | -8.8 | 77.44 |
| 8 | 51 | -2.8 | 7.84 |
| 9 | 57 | 3.2 | 10.24 |
| 10 | 38 | -15.8 | 249.64 |

Average counts $= \bar{n} = 53.8$

**Table 2. The number of counts of Co-60 gamma source for G-M sensor**

| Sr: | $n_i$ | $n_i - \bar{n}$ | $(n_i - \bar{n})^2$ |
|---|---|---|---|
| 1 | 549 | -6.7 | 44.89 |
| 2 | 554 | -1.7 | 2.89 |
| 3 | 561 | 5.3 | 28.09 |
| 4 | 544 | -11.7 | 136.89 |
| 5 | 540 | -15.7 | 246.49 |
| 6 | 532 | -23.7 | 561.69 |
| 7 | 561 | 5.3 | 28.09 |
| 8 | 557 | 1.3 | 1.69 |
| 9 | 596 | 40.3 | 1624.9 |
| 10 | 563 | 7.3 | 53.29 |

Average counts $= \bar{n} = 555.7$

**Table 3. The number of counts of Co-57 gamma source for G-M sensor**

| Sr: | $n_i$ | $n_i - \bar{n}$ | $(n_i - \bar{n})^2$ |
|---|---|---|---|
| 1 | 43 | 20.9 | 436.81 |
| 2 | 25 | 2.9 | 8.41 |
| 3 | 21 | -1.1 | 1.21 |
| 4 | 26 | 3.9 | 15.21 |
| 5 | 13 | -9.1 | 82.81 |
| 6 | 21 | -1.1 | 1.21 |
| 7 | 17 | -5.1 | 26.01 |
| 8 | 18 | -4.1 | 16.81 |
| 9 | 21 | -1.1 | 1.21 |
| 10 | 16 | -6.1 | 37.21 |

Average counts $= \bar{n} = 22.1$

**Table 4. The number of counts of Cd-109 gamma source for G-M sensor**

| Sr: | $n_i$ | $n_i - \bar{n}$ | $(n_i - \bar{n})^2$ |
|---|---|---|---|
| 1 | 39 | -2.8 | 7.84 |
| 2 | 40 | -1.8 | 3.24 |
| 3 | 46 | 4.2 | 17.64 |
| 4 | 24 | -17.8 | 316.84 |
| 5 | 39 | -2.8 | 7.84 |
| 6 | 49 | 7.2 | 51.84 |
| 7 | 48 | 6.2 | 38.44 |
| 8 | 38 | -3.8 | 14.44 |
| 9 | 42 | 0.2 | 0.04 |
| 10 | 53 | 11.2 | 125.44 |

Average counts $= \bar{n} = 41.8$

Statistical Error for G-M sensor and Activities of Gamma Sources are as follows.
For Mn-54 gamma source,

$$\bar{n} = \frac{n_i}{N} = 53.8 \quad (1)$$

$$\sigma^2 = \frac{1}{N-1}\sum_{i=1}^{N}(n_i - \bar{n})^2 \quad (2)$$

Statistical error $\sigma = 10.1959$ (3)

$T_{1/2}$=312.3 d

$A_0$=1 µCi

$\lambda$= 0.693/ $T_{1/2}$

$$A = A_0\, e^{-\lambda t} = 0.002219\ \mu Ci \quad (4)$$

We calculated the statistical error and activities for Co-60, Co-57 and Cd-109 by using equation(2) and equation (4). The results are shown in table 5.

**Table 5. Statistical Error of GM sensor and Activities for Various Gamma Sources**

| Gamma Sources | Statistical error | Activity (µCi) | |
|---|---|---|---|
| | | $A_0$ May,2013 (µCi) | A May, 2019 (µCi) |
| Mn-54 | 10.1959 | 1 | 0.00775 |
| Co-60 | 17.41040 6 | 1 | 0.54406 |
| Co-57 | 8.34599 | 1 | 0.00375 |
| Cd-109 | 8.0526 | 1 | 0.04307 |

## 4.1. Counts/Interval vs. Distance Studies

The datas in the Figure 4 to Figure 7 were measured by monitoring gamma radiation at various distances for Mn-54 , Co-60 , C0-57 and Cd-109 from G-M sensor. Datas were measured with the running intervals set at 60 seconds. After each 60 seconds intervals, the source was moved 2.5 centimeter further from the source. It is seen that the number of gamma radiations for small distance are more than for large distance from gamma sources.

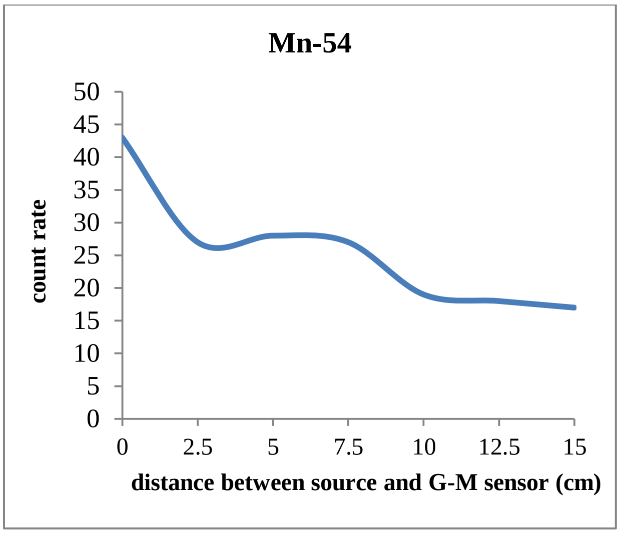


**Figure 4. Counts of Mn-54 gamma source for various distance**

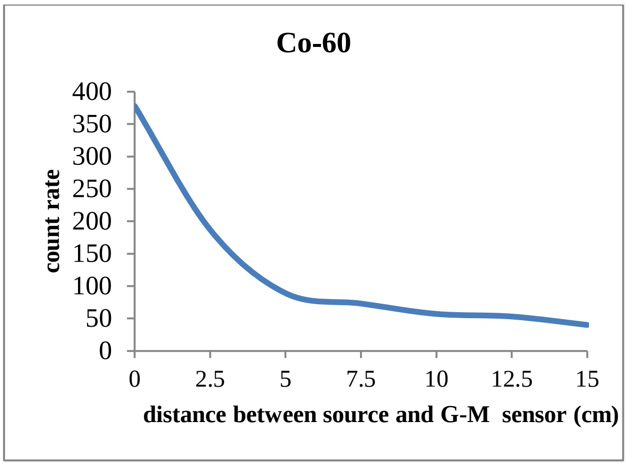


**Figure 5. Counts of Co-60 gamma source for various distance**

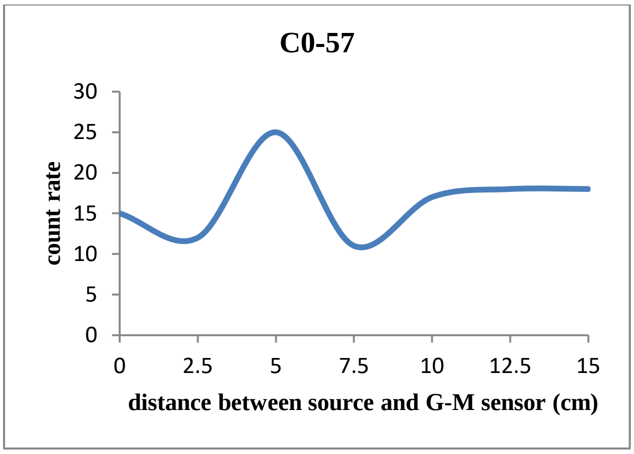


**Figure 6. Counts of Co-57 gamma source for various distance**

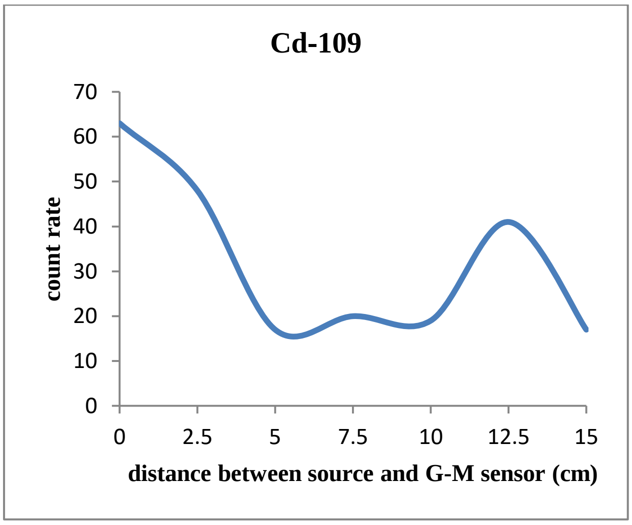


**Figure 7. Counts ofCd-109 gamma source for various distance**

## 4.2. Counts/Interval vs. Shielding Studies

The gamma radiations were measured by G-M sensor with an increasing number of pieces of aluminum sheets placed between the gamma source and a G-M sensor. Datas were measured with the running intervals set at 60 seconds. After each 60 seconds intervals, another pieces of aluminum sheet was placed between the gamma source and the radiation monitor. The results are shown in Figure 8 to 11. It is observed that the number of gamma radiations are less than in more number of aluminum sheets.

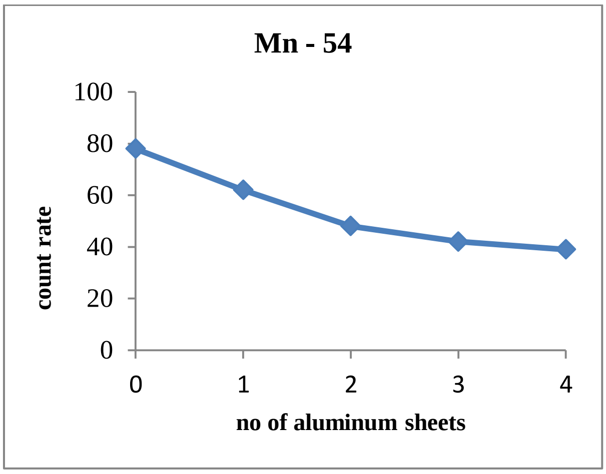


**Figure 8. Counts of Mn-54 gamma source for the number of aluminum Sheets**

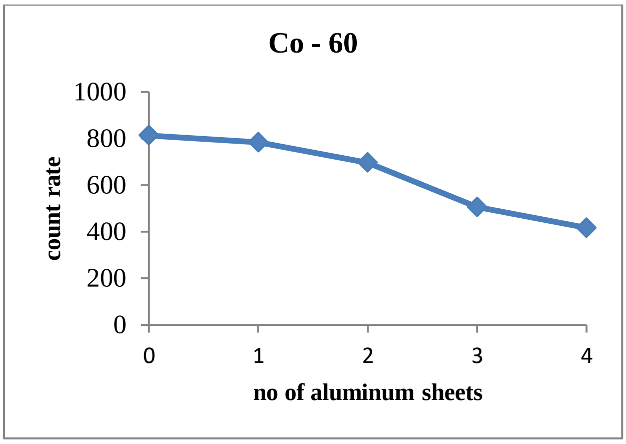


**Figure 9. Counts of Co-60 gamma source for the number of aluminum Sheets**

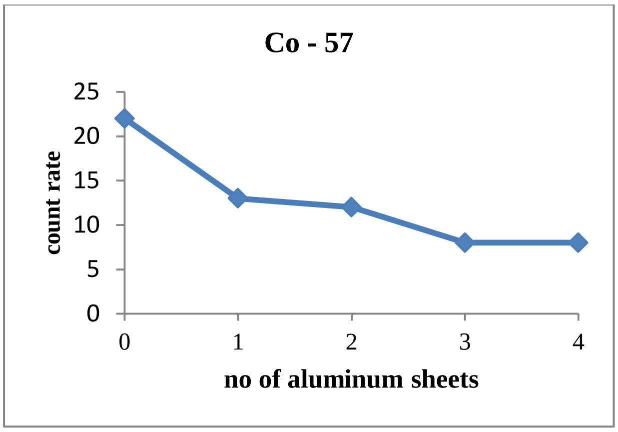


**Figure 10. Counts of Co-57 gamma source for the number of aluminum Sheets**

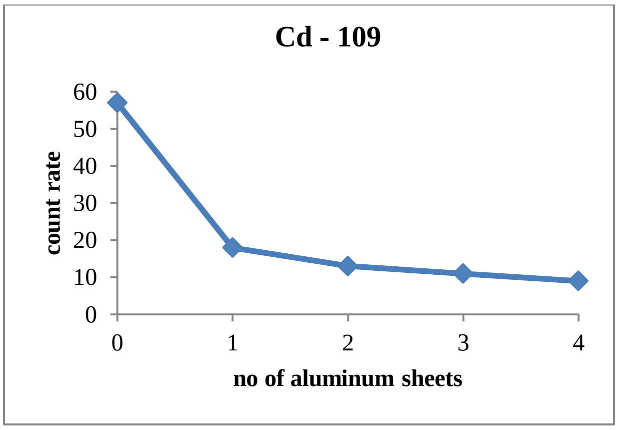


**Figure 11. Counts of Cd-109 gamma source for the number of aluminum Sheets**

## 5. CONCLUSION

We measured gamma radiations by G-M sensor from gamma sources such as Mn-54, Co-60, Co-57 and Cd-109 by G-M sensor. It is observed that we obtained the statistical error for those measurements, the nature of gamma radiations and the activities of sources in May, 2019 at Department of Physics, University of Research Centre, Monywa.

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