The Energy from Cabalt-60 Calibration Source

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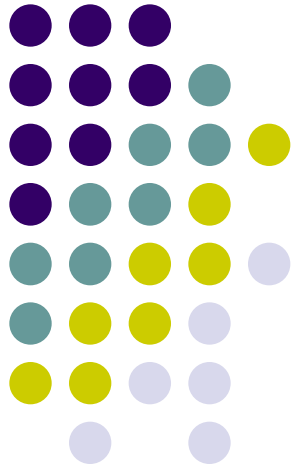


Introduction

- Since the cabalt-60 emits two gamma, we try to understand the ADs by using the cabalt-60 calibration source.

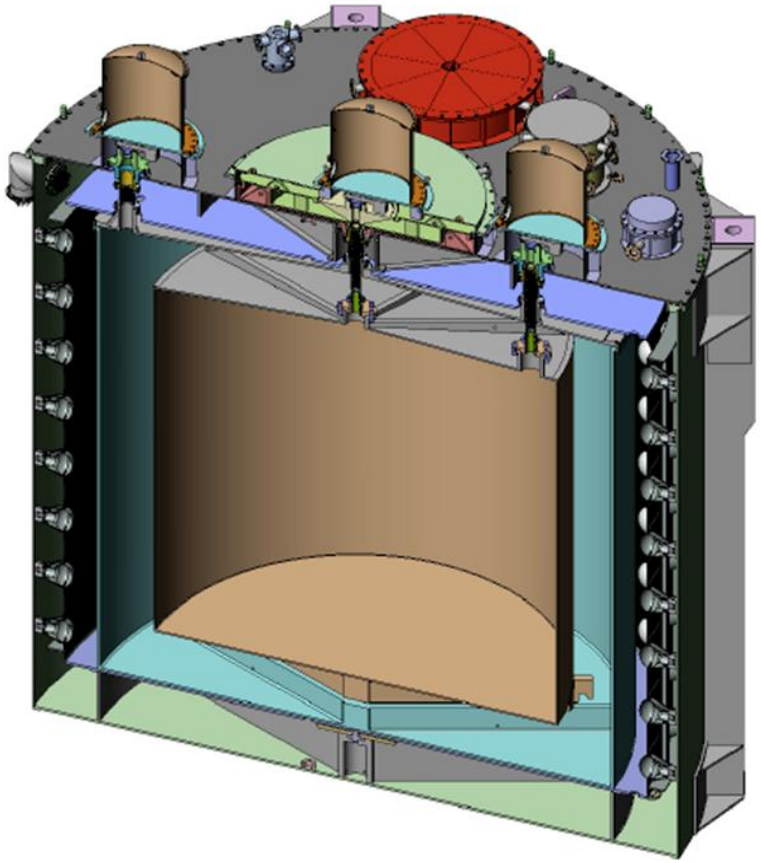
Detector

3 nested cylinders:

Inner: 20 tons Gd-doped LS (d=3m)
Mid: 20 tons LS (d=4m)
Outer: 40 tons mineral oil buffer (d=5m)

Each detector:

192 8-inch Photomultipliers
Reflectors at top/bottom of cylinder



Method

Step1. We put the source, cabalt-60, into the center of our detector.

Step2. We generate 100,000 events by NuWa.

Step3. Using ROOT to plot the energy spectrum of cabalt-60.

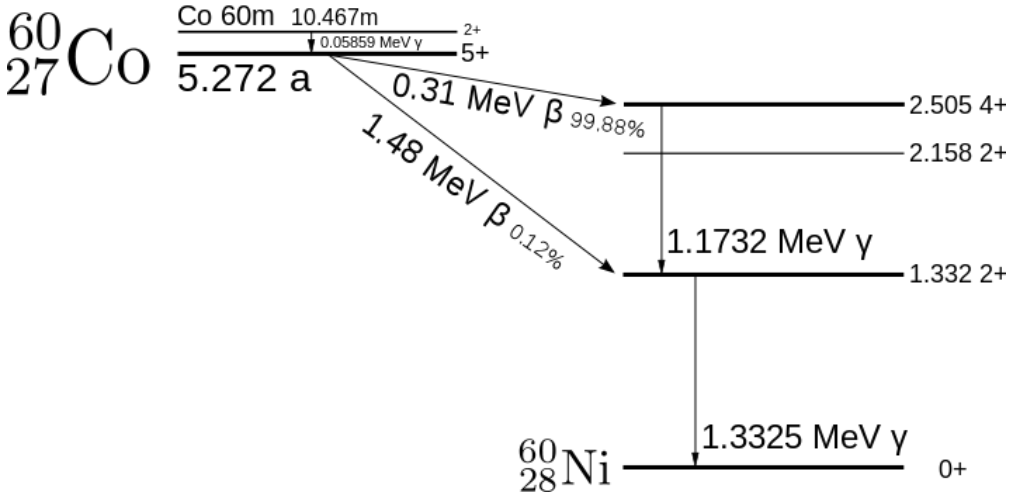
Cabalt-60

- Cabalt-60 is a synthetic radioactive isotope of cobalt with a half-life of 5.27 years. It is produced artificially by neutron activation of the isotope cabalt-59.
  Cabalt-60 decays by beta decay to the stable isotope nickel-60.
- The activated nickel nucleus emits two gamma rays with energies of 1.17 and 1.33 MeV, hence the overall nuclear equation of the reaction is

$$^{59}_{27}\mathrm{Co} + \mathrm{n} \rightarrow {}^{60}_{27}\mathrm{Co} \rightarrow {}^{60}_{28}\mathrm{Ni} + \mathrm{e}^{-} + \text{gamma rays.}$$

Cabalt-60

- The diagram shows a (simplified) decay scheme of cabalt-60 and cabalt-60m. The main β-decay transitions are shown. The probability for population of the middle energy level of 2.1 MeV by β-decay is 0.0022%, with a maximum energy of 665.26 keV.



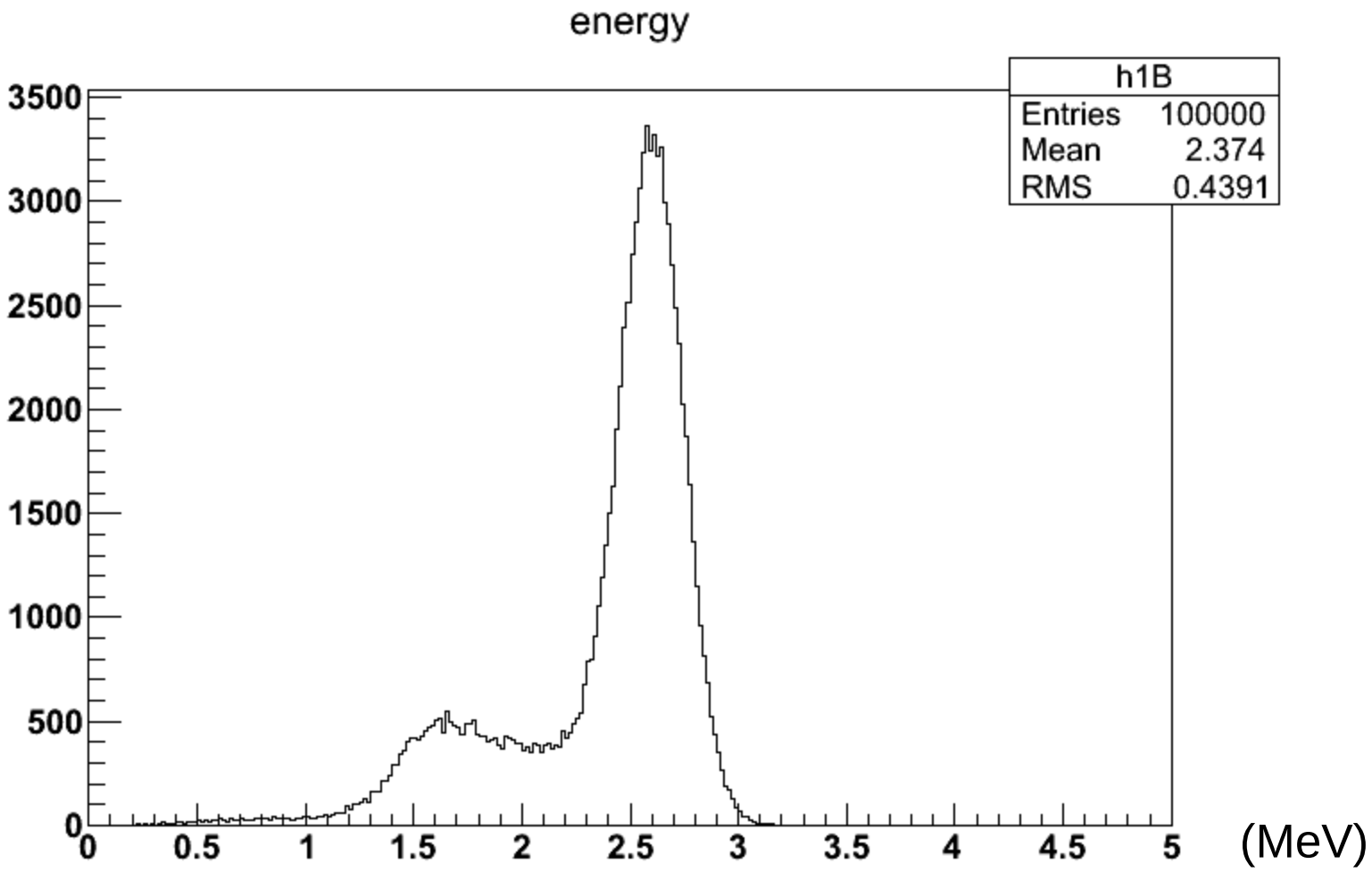
Cabalt-60

- Energy transfers between the three levels generate six different gamma-ray frequencies. In the diagram the two important ones are marked. Internal conversion energies are well below the main energy levels.

Cabalt-60

- Cabalt-60m is a nuclear isomer of cabalt-60 with a half-life of 10.467 minutes. It decays by internal transition to cabalt-60, emitting 58.6 keV gamma rays, or with a low probability (0.22%) by β-decay into nickel-60.

Simulation Result:
Energy Distribution of Cabalt-60



Summary

- We discover the biggest number of count at about 2.5(MeV).
- Because cobalt-60 emits two gamma rays with energies of 1.17 and 1.33(MeV) almost at the same time.
- 1.17 + 1.33 = 2.5 (MeV)

Reference

- Wikipedia
- The study of the energy leakage from the cabalt-60 calibration source, Bei-Zhen Hu