The Total and Photo Peak Relative Efficiency Measurement for NaI(Tl) Detector

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Abstract:

In the present work, total and photo peak relative efficiency were measured for NaI(Tl).Two radioactive sources (Co-60 and Cs- 137) with detector NaI(Tl) by size (3" × 3") were used. The range of angles (10°-90°) and the range of distance between the sources and crystal (10-30) cm. The experimental results show:

When increasing the angle the photo peak relative efficiency increasing .And increasing it's the total relative efficiency increase until (50°) after these angle the total efficiency decrease. The photo peak relative efficiency increasing with distance increasing and also the total relative efficiency same behavior.

Introduction:

Scintillation counters, in general, and NaI (Tl) in particular are widely used in various fields of nuclear radiation detection, such as environmental studies [1, 2], nuclear medicine [3], and health physics [4] and high energy physics experimental [5]. The efficiency of the NaI(Tl) Studies from many researcher [6-11] , so the experimental applications surrounded with different materials of different types and thickness like the shielding from the background in low count rate experiments [12,13]. Then, the contribution of scattered Photons from the surroundings will be affect energy spectrum result from NaI (Tl) detector which this contribution depends on gamma [14].But in this work we used different arrangement geometry from previous studies.

Experimental Arrangements:

Figure (1) shows the block diagram of the electronic system which used for detection and effect of angle and figure (2)effect of distance, which consist of the following units:

NaI (Tl) Scintillation Detector (Harshaw):

Size of NaI (Tl) crystals was used in this work (3" × 3"), (7.6 cm x7.6 cm). The photo multiplier tube which used of EMI type and the photosensitizing material of Bialkali (Cs–Sb).

High voltage power supply (EG &G OR TEC-478):

This unit provide the photo multiplier tube by the needed voltage with range (0-2000) V with thermal stability (0-50)°C , and time stability (0.01)hr to (0.02/8hr). Where used (750) V in this work.

Photo multiplier Base with preamplifier (EG & G ORTEC 266):

These units divide the high voltage to the dynodes in the photo multiplier tube equally. The preamplifier was to match the impedance between the detector and the main amplifier.

Multi channel pulse Height Analyzer [The Nucleus (Q.8)]:

This unit consists of Amplifier where this it's responsible for amplifies the input pulses in range (5-320) times and consist range (215, 512, 1024) channel. Where used (1024) channel in this work.

Tow radioactive sources (Co-60 and Cs-137), the material (lead) were used. The angle range (10°-90°) and distance between tow side of shielding material range (10-30) cm, and also the distance between the source and detector was (25) cm.

Results and Discussion:

1- **The effect of angle between two sides of the shielding mater on the photo peak and total relativity efficiency**:

Figure(3) show the results of the effect angle on the photo peak relativity efficiency, with increase angle the photo peak relativity efficiency increase, because the angular distribution photons decrease from the shielding material which decrease from probability interaction by Compton scattering[7,8]. And from this figure we see the photo peak relativity efficiency for Cs-137 greater than Co-60 because the activity of Co-60 less than Cs-137 which led to the number of the photons (Cs-137) more than (Co-60) which interacting with shielding mater. And from figures (4) and

(5) we see the total relativity efficiency increase with angle increase until (50°) after these angle its decrease because the probability interaction by Compton scattering decrease.

2- **The effect of distance between tow sides of shielding mater on the photo peak and total relativity efficiency:**

Figure (6) shows the effect of distance on the photo peak relativity efficiency, where the distance increase the photo peak relativity efficiency increase, because the probability interaction with crystal of detector increase, and the effect of background decrease, and also from figure (7) we see same behavior because the effect of photons scattering decrease and the probability photons interaction with crystal of detector increase, but this probability decrease with mater shielding. And we see from figures (6) and (7) the photo peak and total relative efficiency by using Cs-137 source greater than Co-60 source because the photons energy which emitted from Cs-137 source less than photons energy which emitted from Co-60.

Conclusion:

With increase the angle photo peak relative efficiency increase. And with increase the angle the total relative efficiency increase until (50°) after these angle its decrease. And the photo peak and total relative efficiency increase with distance increase.

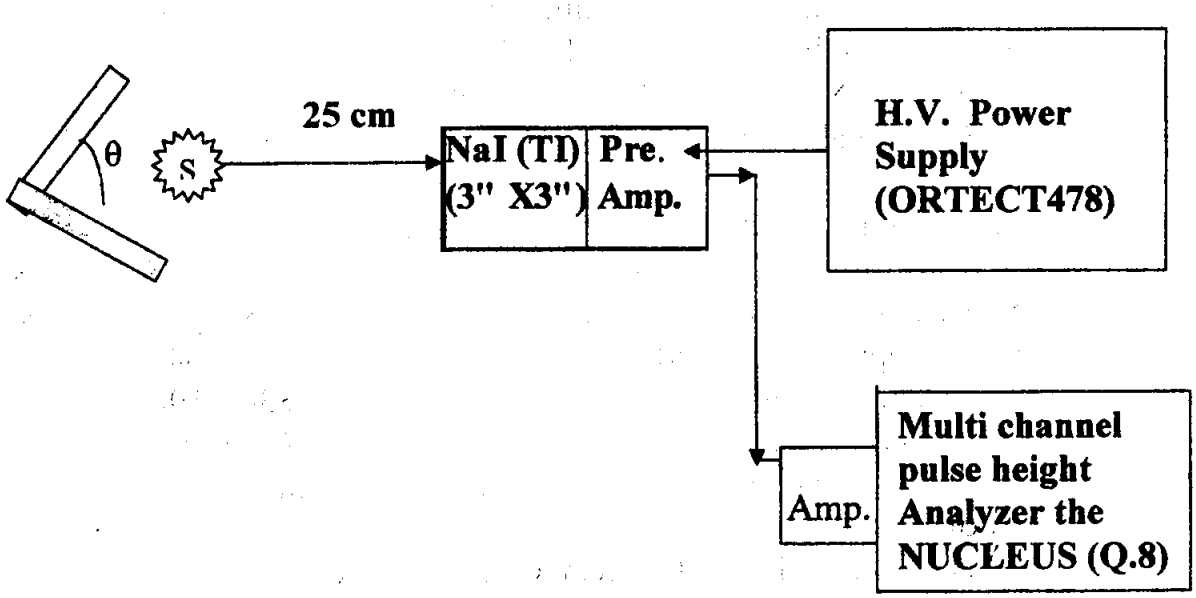

Fig (1): Shows the block diagram the experimental arrangements of effect the angle.

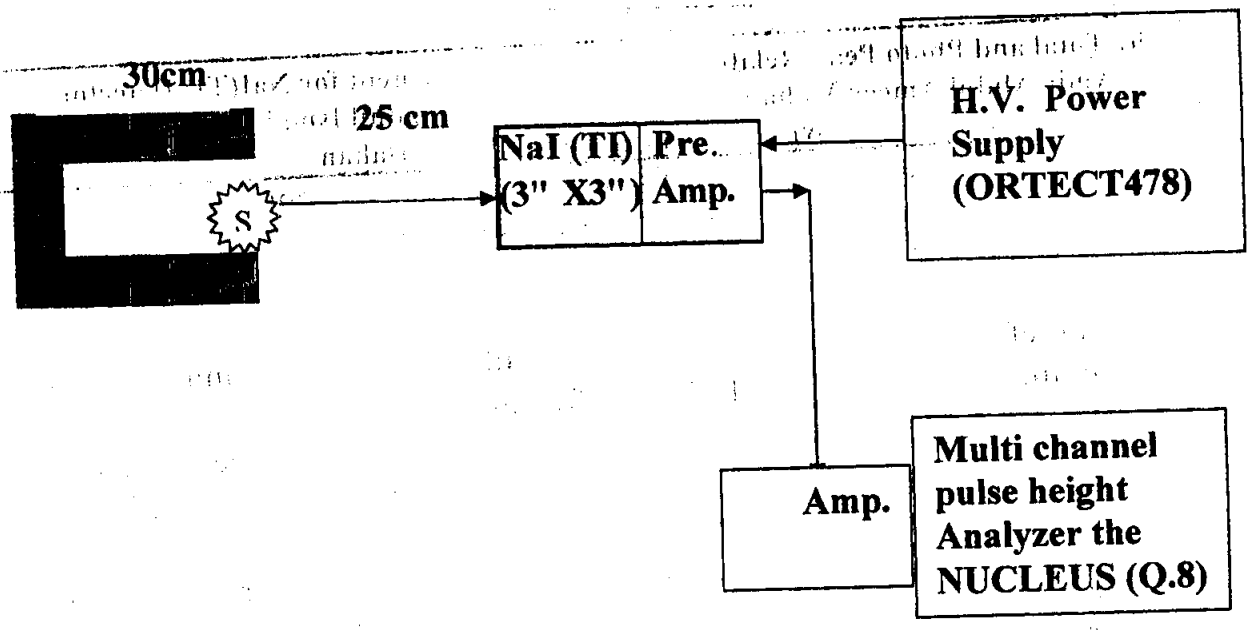

Fig (2): Shows the block diagram the experimental arrangements of effect the distance between tow sides of shielding.

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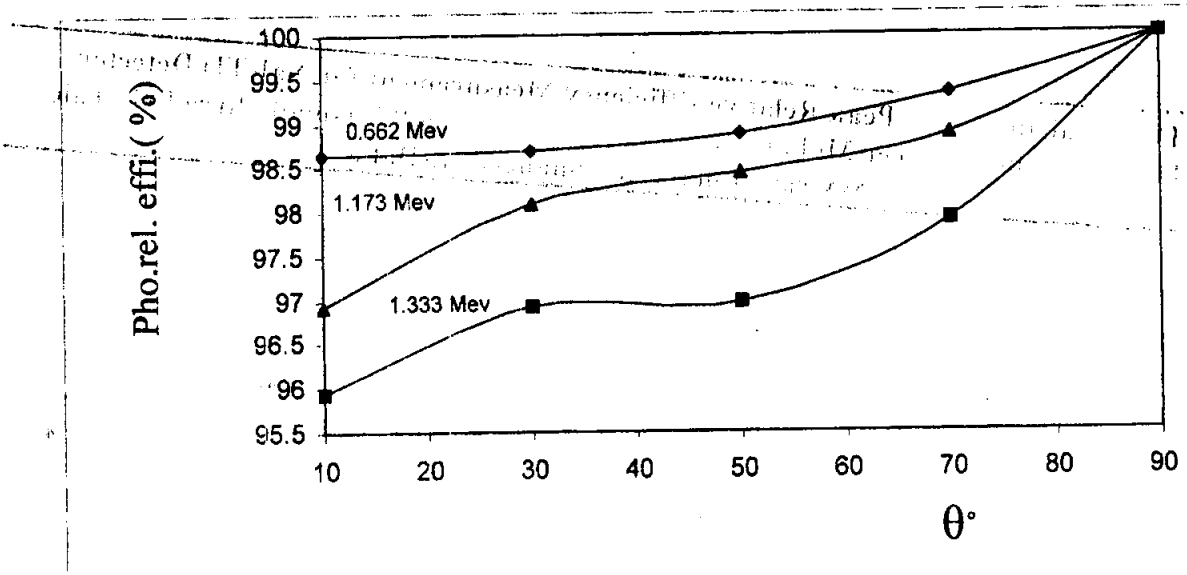

Figure(3) The relation between an angle and photo peak relative efficiency %

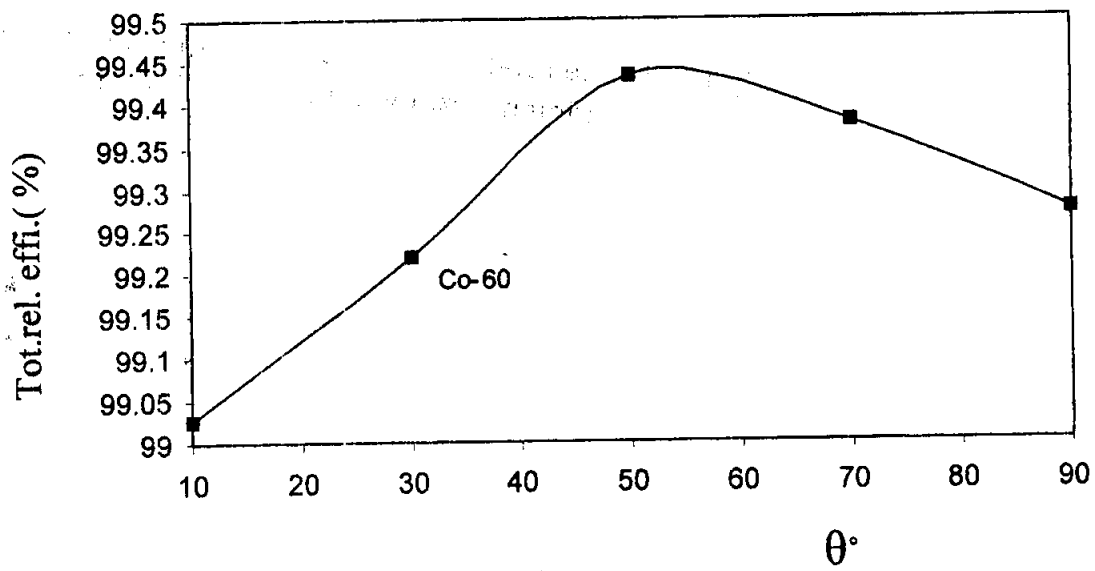

Figure (4) The relation between an angle and total relative efficiency % by using Co-60 source.

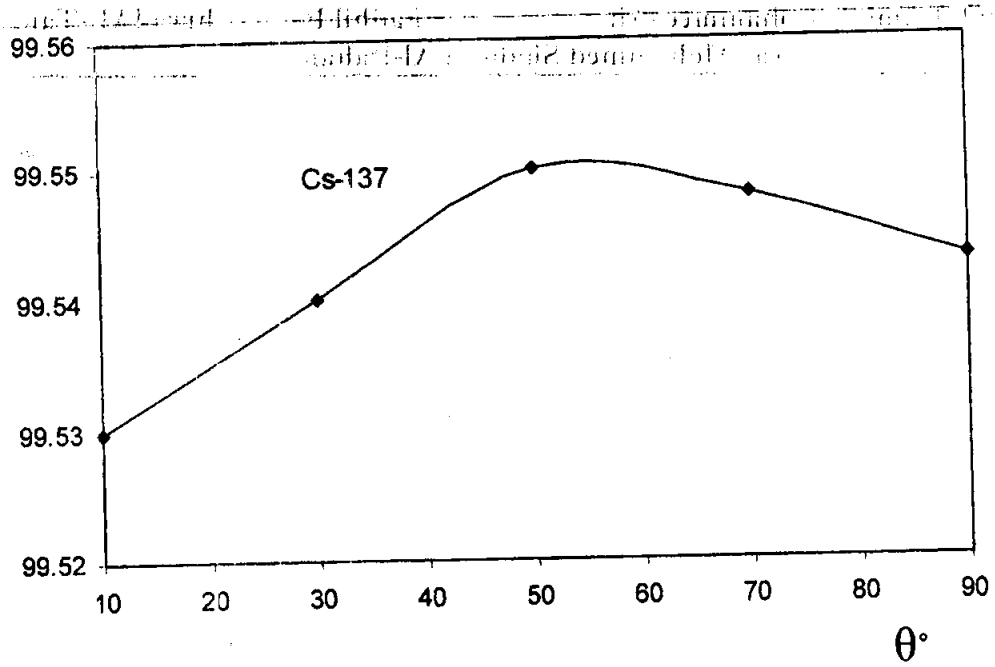

Figure (5) The relation between an angle and total relative efficiency % by using Cs-137 source.

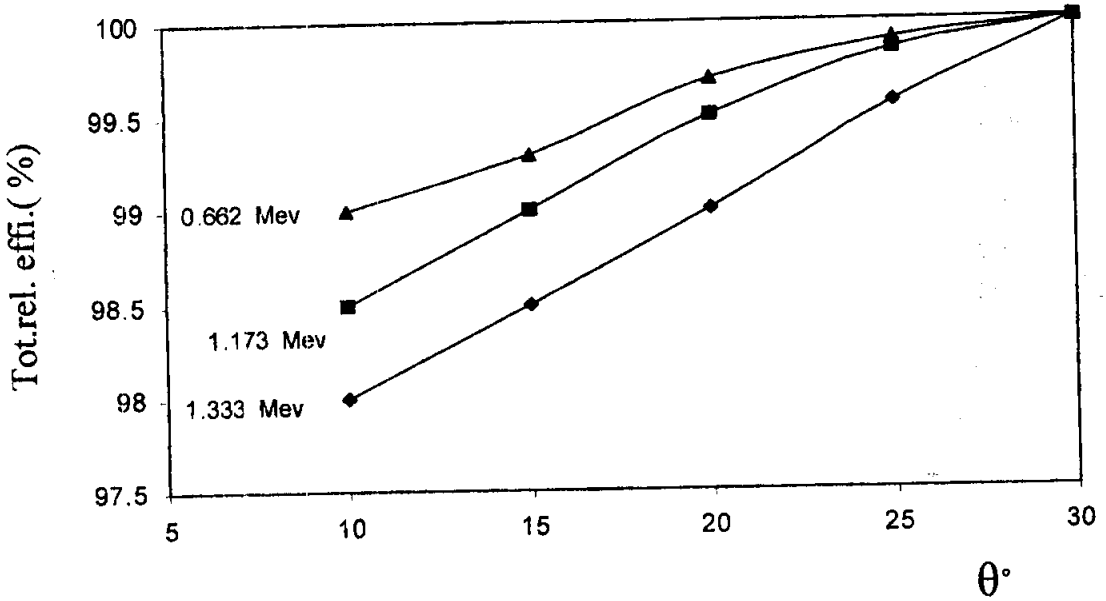

Figure (6) The relation between the distance and photo peak relative efficience %