# "Effect of the Distance of Surroundings material on the Signal / Noise Ratio of the NaI (Tl) Detectors"

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## تأثير المسافة للمواد المحيطة على نسبة النبضة / الضوضاء للكواشف الوميضية   NaI ( Tl )

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## Abstract:

In the present work the effect of the distance surroundings material on the signal to noise (S/N %)  are studied , for the two sizes of scintillation detectors NaI (Tl); (3"X3" and 1.5"X1.5"),by using two radioactive sources (Co- 60 and Cs -137) and Iron and P.V.C cylinders.                                                                    The experimental results shows that the Signal to the noise ratio (S/N %) are increasing in both the distance and photons energy increasing. The effect of size of NaI(Tl) on the ratio of (S/N %) as well as the type of materials dependence is present too.

## الخلاصة

درس في هذا البحث تأثير المسافة للمواد المحيطة على نسبة النبضة / الضوضاء ( S/N % ) بأستخدام الكاشف الوميضي  NaI ( Tl ) وبحجمين       ( "3×"3 , "1.5×"1.5 ) ولمصدرين مشعين ( السيزيوم – 137 والكوبلت -60 ) ولمادتين ( البولي فنيل كلورايد الحديد ) .

واضهرت النتائج العملية أن نسبة النبضة / الضوضاء  ( S/N % ) تزداد بزيادة كل من المسافة وطاقة الفوتون ، وكذلك تبين انه بزيادة حجم الكاشف تزداد نسبة النبضة / الضوضاء  ( S/N % ) .

## Introduction

Many factors affecting the scintillation detector NaI (Tl) were studied because of the wide use of this detector. The effect of the temperature on the NaI (Tl) detector properties has been studied [1-5]. The efficiency of the NaI (Tl) detectors has been studied also [6-9].The properties of the energy spectra i.e. the response functions of the NaI (Tl) crystals have been studied [10-14]. The NaI (Tl) detector is widely used in various fields of nuclear radiation detection, such as environmental studies[15,16]and nuclear medicine[17].So that the experimental applications surrounding with different materials of different types and thickness like the shielding from the background in low count rate experiments [18,19]. Then, the contribution of scattered photons from the surrounding will be affect energy spectrum result from NaI (Tl) detector. This contribution depends on gamma energy [20].

## *Experimental Arrangements*

The block diagram of the electronic system which used for detection are shown in figure (1), which consist of the following units:

**NaI (Tl) Scintillation Detector (Harshaw)**

Two sizes of NaI (Tl) crystals were used in this work: 3" $\times$ 3" and 1.5" $\times$ 1.5". The photomultiplier 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 provides the photomultiplier tube by the needed voltage with range (0-2000) V with thermal stability (0-50)$\overset{\circ}{}$ C, and time stability (0.01) hour to (0.02/8hour).

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

This unit divides the high voltage to the dynodes in the photomultiplier 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 which responsible for amplifies the input pulses in range (5-320) times and consist range (215, 512, 1024) channel.

The materials used in this research are two types (Iron and P.V.C.) with cylindrical shapes and different diameters, and two radioactive sources (Co – 60 and Cs – 137).Where the activity for (Co-60) was (125μci) and for (Cs-137) was (146 μci).

## Results and Discussion:

The results of this work are displayed in the figures (2) to (5) and we will be demonstrated in the follow sections.

## 1.Distance surrounding materials:

The relationship between the ratio of the (S/N%) with distances of surroundings materials (D) are displayed in the figs.(2) and (3), from these figures we see the ratio of the (S/N%) increasing with increase the distances of surroundings materials because the probability of intraction by Compton Scattering with surrounding material decreasing, which lead to decrease in the scattering region in the energy spectrum and these increasing will be effective on the (S/N%).

## 2- Crystal size:

Fig. (4) shows the comparssion between (S/N) of Iron by using 1.5"x1.5" and 3"x 3" detectors, from this figure the ratio of (S/N) for (3" x 3") detector greater than for (1.5" x1.5") because the solid angle for (3"x3") greater than for

(1.5" x1.5") this led to the number of photons interaction for (1.5" x1.5") less than (3" x 3" ) .

## 3. Atomic Number:

Fig. (5)shows comparssion between(S/N%) of P.V.C. and Iron material by using 1.5"x1.5" detector, the ratio of (S/N%) for P.V.C matter greater than for Iron because the Compton Scattering by used P.V.C less than Iron matter which causes decreasing the probability interaction by Compton Scattering with atomic number decrease for the surroundings materials[21,22] .

## 4. Photon energy:

the relationship between (S/N%) and photon energy with P.V.C matter and using (1.5" ×1.5") detector are shown in the figure (6), from this figure the ratio of the (S/N%) increased with the photons energy increasing because the ratio of Compton scattering in the spectrum at used Cs-137 less than Co-60 ,where the Compton scattering is proportional direct with photon energy.

## Conclusion

All the results obtained from this work indicated that the signal / noise are decreasing with decreased of distance of the surrounding materials, the size of NaI(Tl) and photons energy. It's also found that the ratio (S/N %) for P.V.C matter greater than for Iron.

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Source       surroundings
            Material

NaI (TI)   Pre.Amp.

H.V.   Power Supply (ORTECT478)

Shielding

Amp

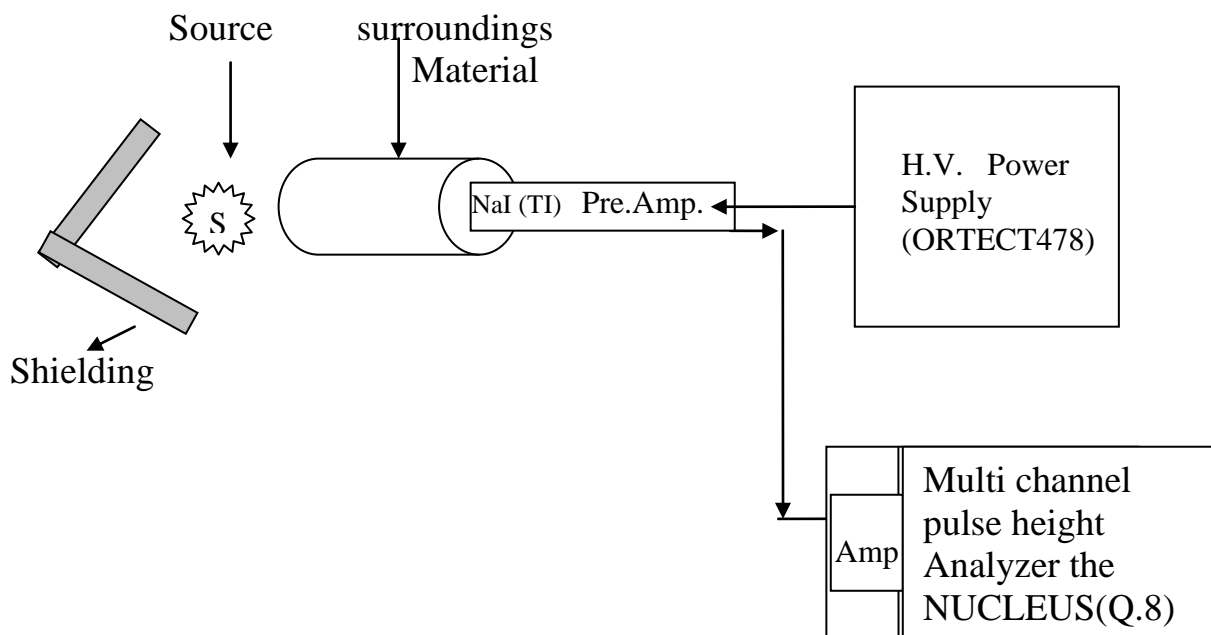Multi channel pulse height Analyzer the NUCLEUS(Q.8)

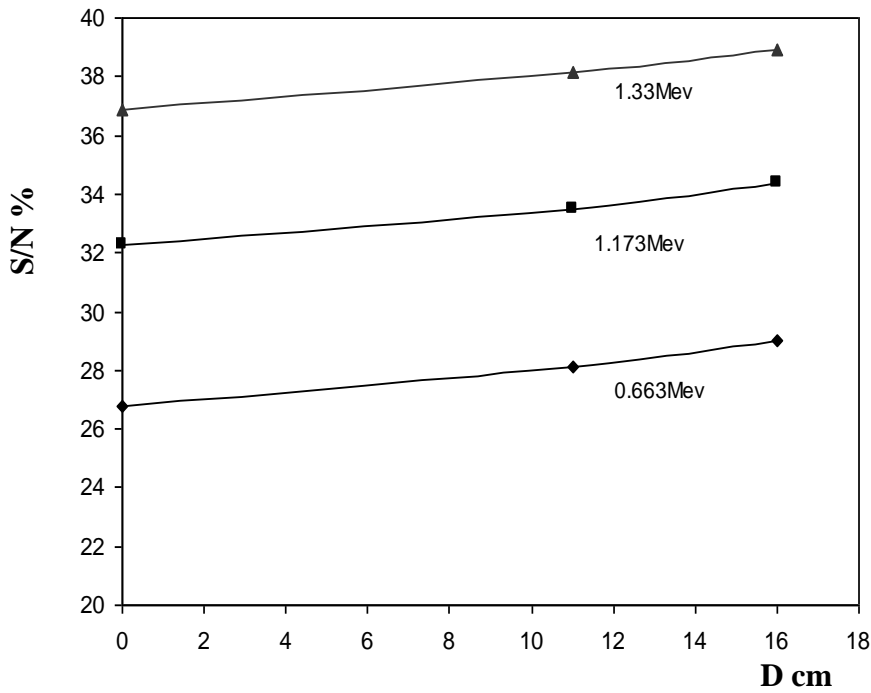Fig. (1): A block diagram for the detection system

Fig.(2) : Relationship between S/N % and distance for P.V.C. matter with different energy and using (1.5" ×1.5") detector.
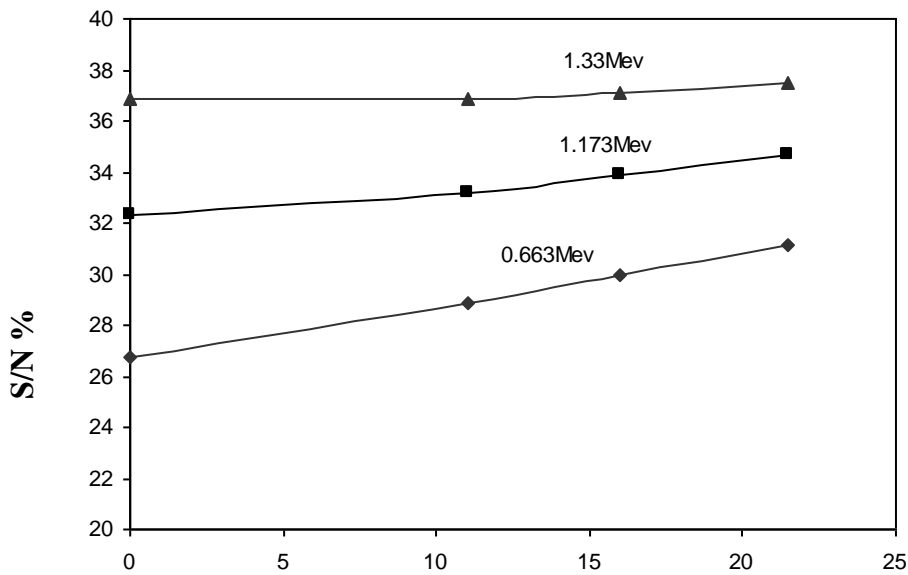


Fig.(3) : Relationship between S/N % and distance for Iron matter with different energy and using (1.5" ×1.5") detector
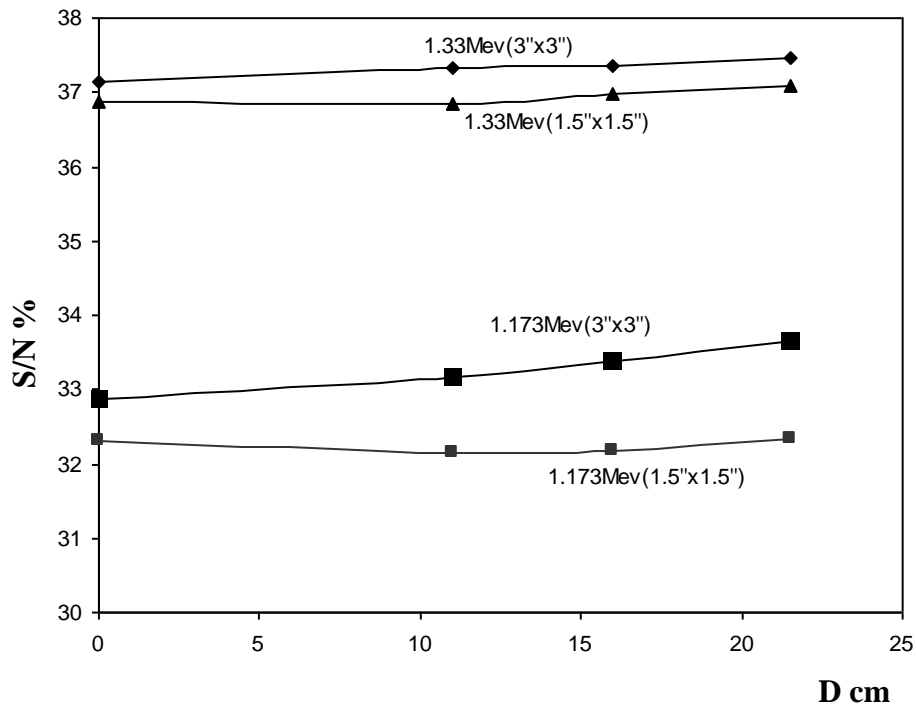
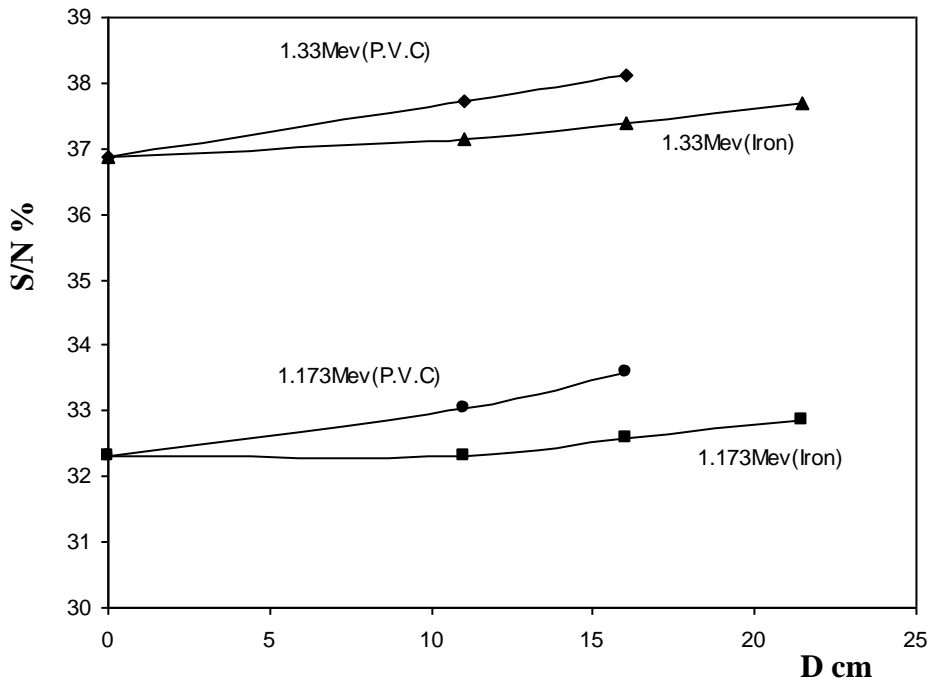Fig (4): Shows the comparssion between (S/N)  of Iron by using 1.5"x1.5" and 3"x 3" detectors



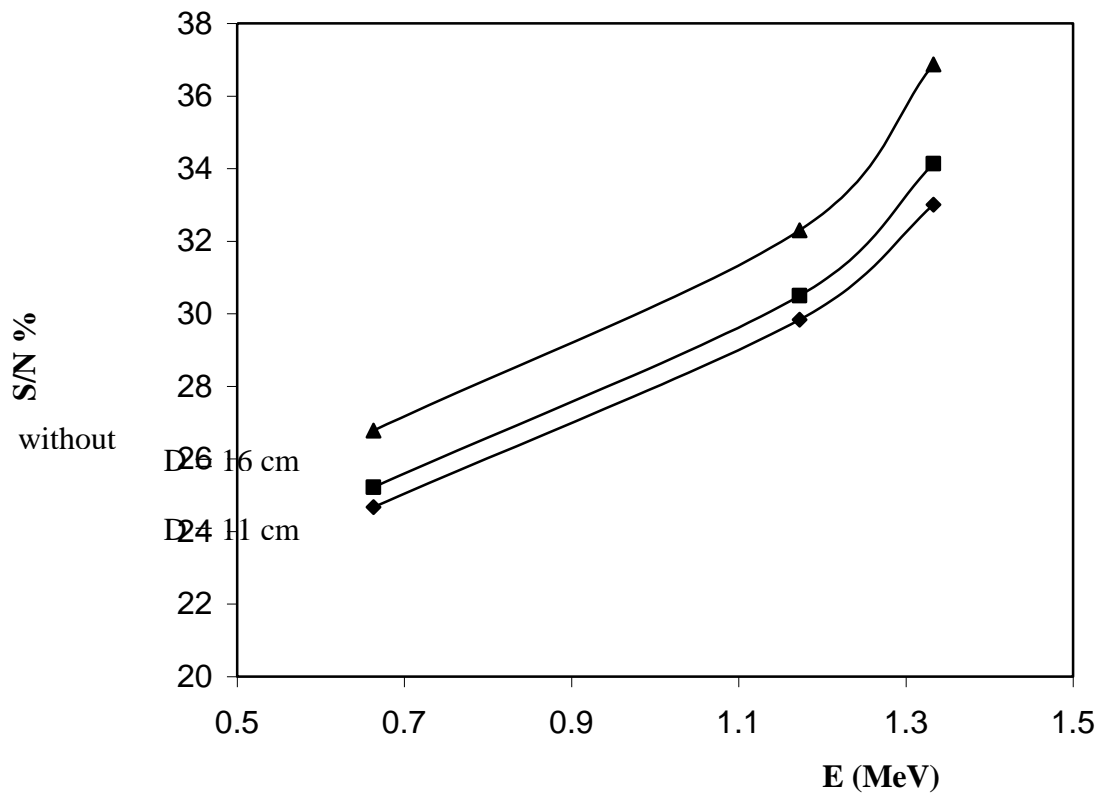Fig (5): Shows comparssion between (S/N) of P.V.C.  and Iron material by using 1.5"x1.5" detector .

Fig.(6) : Relation ship between S/N % and photon energy with P.V.C mater and using (1.5" ×1.5") detector