Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 3(I), pp. 25251-25253, March, 2018

ISSN: 0976-3031

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

INVESTIGATION OF A NEW TECHNIQUE FOR SEPARATING SIMULTANIOUSLY PRODUCED SCINTILLATION AND CHERENKOV RADIATION

Parmanand Prasad Arya*

Department of Physics, NRI & College Bihar Sharif (Nalanda)

DOI: http://dx.doi.org/10.24327/ijrsr.2018.0903.1824

ARTICLE INFO

Article History:

Received 11th December, 2017
Received in revised form 25th January, 2018
Accepted 4th February, 2018
Published online 28th March, 2018

ABSTRACT

A fast electronic circuit for separating simultaneously produced scintillation and Cherenkov radiation is described. In the design of the circuit, use is made of the fact that the decay time of the pulse of scintillation radiation produced in the plastic scintillator is longer than that of the Cherenkov radiation emitted in the radiator.

INTRODUCTION

The Cherenkov radiation is produced when charged particles travels faster than the speed of light in a given medium. As nothing can travel faster than the speed of light in a vacuum, Cherenkov radiation can only happen in a medium such as air, water or glass. Assuming we are dealing with heavy water, this means that the speed of light in heavy water is 25% slower. If charged particles travel faster than this speed in heavy water, it will emit Cherenkov radiation.

In high energy experiments, the separation of scintillation and Cherenkov radiation simultaneously produced in a scintillation detector is desirable; otherwise the particle detection becomes complicated. For example, in the light guide of a scintillation detector, Cherenkov radiation may be emitted due to the passage of the fast particles through the light guide of the detector, and the Cherenkov pulse must be separated from the scintillation pulse. Several methods have been devised to accomplish this separation of the pulses.

In one of the methods, the uni-directional propagation property of the Cherenkov radiation at small angles from the track of fat moving particles in the radiator was utilized to separate it from isotropically produced scintillation radiation. In a cosmic rays experiment, in which the above principle was utilized, following two main difficulties were faced:

1. The number of photoelectrons produced due to Cherenkov radiation is much less than that produced due to the scintillation radiation.
2. Amount of data taken in the cosmic rays experiment was not large enough to enable high statistics data analysis. To overcome this difficulty, high energy fast to particles emerging from the Nirmod, a proton synchrotron at the Rutherford Laboratory, U.K. were utilized as the source of these radiations. However, wide spread of the pulse heights made it difficult to separate them.

In another method, the fact that the rise time of the pulse produced due to Cherenkov radiation is faster than that of the pulse produced due to scintillation radiation was utilized. In general, in a radiator, scintillation produces more light than the Cherenkov radiation. Consequently, the pulse height of the scintillation radiation is larger than the pulse height of the Cherenkov radiation. However, the output pulses of the photomultiplier tube (PMT) were reflected, delayed and combined with original pulses. As a result, the resultant of the original pulse and its reflected (inverted) and delayed pulse were reduced both in pulse height and width depending upon the amount of delay used. So, both kinds of radiations could be distinguished by the shape and the size of the resultant pulse. In order to introduce the fine delay and reflect the PMT pulse, a clip was made simply by soldering both wires of a co-axial cable at one end and the other end of the cable was plugged in one of the outputs of the PMT (1ft of the cable= 5 nano second). A three inch long clip, which introduced a delay of 1.25 nano second, was found best for separating simultaneously produced scintillation and Cherenkov radiation.

Corresponding author:* **Parmanand Prasad Arya
Department of Physics NRI & College Bihar Sharif (Nalanda)

CIRCUIT DETAILS AND DISCUSSION

A fast electronic circuit is used to separate the two simultaneously produced radiations. The technique employed in this circuit depends upon the fact that the decay time of the Cherenkov pulse is smaller than that of the scintillation pulse. For example, typical decay times for scintillation and Cherenkov pulses are of the order of 3-5 nano second and 1-2 nano second respectively (Fig. 1). Therefore, the circuit is designed in such a way that it triggers only after the pulse has reached its peak and has started to decay, thus making it possible to compare the decaying edge of the pulse with a pre-determined reference.

This fast electronic circuit is basically a slope comparator. It compares the slopes of the decaying parts of these pulses. An output is provided by the circuit when the slope of the decaying part of the pulse is comparable to a pre-determined references slope. For example, if it is desired to count the scintillation pulses, (rejecting any Cherenkov pulses at the same time) values of the circuit parameters are so assigned as to produce a reference slope which is in the range of the slope of the selected pulses. The setting of the reference slope is achieved by adjusting the value of the resistor R (Fig.2.). The block diagram in which a PMT pulse is suitably amplified and is processed by a slope comparator is shown in Fig.3.

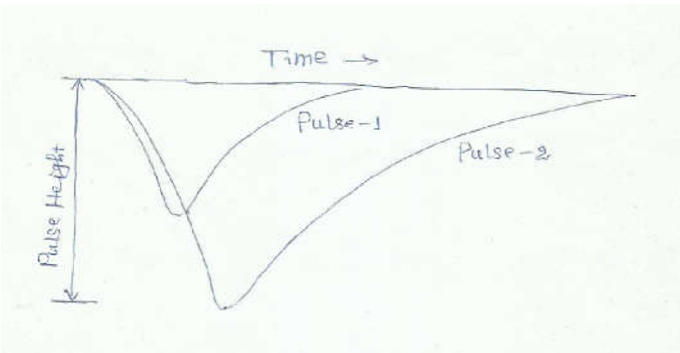

Figure 1 Typical PMT pulses due to scintillation radiation (Pulses-2) and Cherenkov radiation (Pulse-1).

The slope comparator is shown in Fig.2. It is constructed from a high speed voltage comparator of the type µA 710 which has a propagation time of 40 nano second. The signal E form the PMT amplifier is applied through a capacitor C of suitable value to the inverting input of the op-amp. Another voltage signal E_R called the reference voltage is applied to the same inverting input through a resistance R.

The two signals together force a non-zero current to flow into the comparator input. Under these conditions, the comparator output is driven to one of two voltage limits i.e $+V_Z$ or $-V_Z$ (Fig.4). Whenever the rate of change of the signal e (i.e. de/dt) exceeds a constant, which is set by the values of the resistance R capacitor C and the reference voltage E_R . the output of the comparator changes the states. The current developed in the capacitor C by the signal e_i is compared with that produced in the resistance R by the reference signal E_R. and switching occurs when the combined current changes polarity. Since this change takes place at the zero current crossing, the change of the state is governed by the equation: $d_{e1}/dt = -E_R/RC$

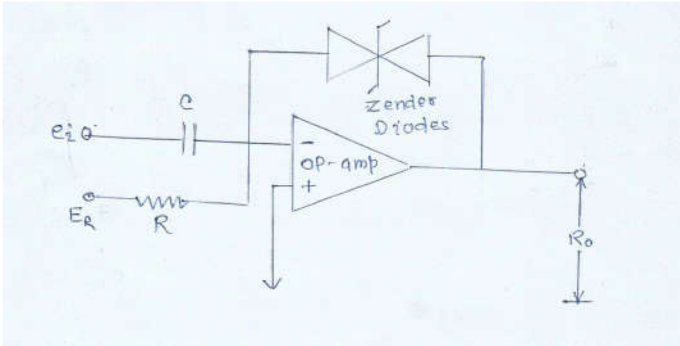

Fig 2 Slope Comparator

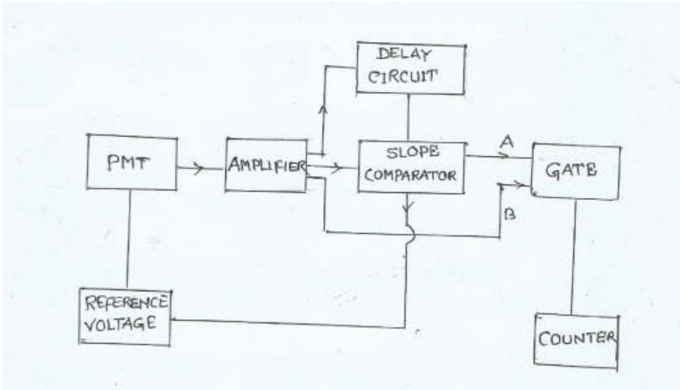

Fig 3 Block diagram of the complete device

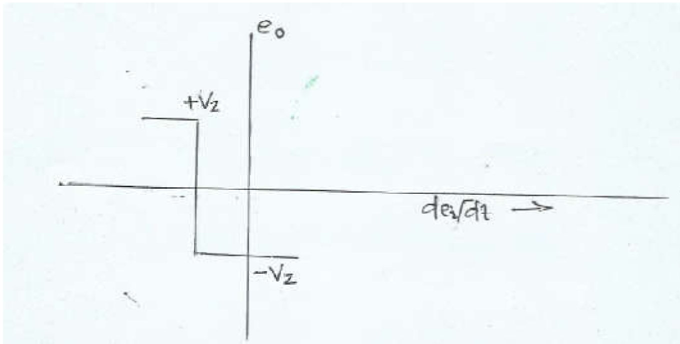

Fig 4 Typical output of the slope comparator

The output from the comparator is shown in Fig.4. With 5 volt Zener diode's in feedback loop of the op-amp circuit, a transistor- transistor logic (TTL) compatible output is obtained for easy interfacing with a counter. Reference voltage E_R is applied through a set-reset gate which itself is operated by the negative going edge of the pulse from the PMT amplifier. The propagation time of this gate together with a suitable delay circuit provides the required delay of the order of 2-3 nano second (Fig.3).

The output of the comparator changes the state only if the time constant of the signal e is comparable to that set by the value of capacitance C and resistance R. Output (Pulse A) from the comparator is fed into a two input AND gate and second input (Pulse B) to this gate obtained from the PMT amplifier (Fig.3). The And-gate provides an output only when both of these pulses (Pulses A and B) are present. This makes it possible to separate the scintillation pulse from the Cherenkov pulse. The presence of any of the selected pulses is then counted as an event by the counter.

CONCLUSION

The fast electronic circuit described in the paper makes use of the decaying part of the scintillation or the Cherenkov radiation pulses. The slope of one of these pulses to be counted is compared by a slope comparator which gives an output only when the selected scintillation or the Cherenkov pulse is present. This pulse is then counted by a counter after passing through a suitable gate. By a simple readjustment of the comparator parameters, the circuit can be made to select either of these pulses as required by the experiment.

References

1. Upadhyay P.N., *J.Sci.Res Physics* (India) 28(1978),117.
2. Upadhyay P.N *Expt,.Tech Physics* 26,(1978)565.
3. Upadhyay P.N *Expt,.Tech Physics* 27,(1979)345.
4. Signetics, U.S.A., Linear Integrated Circuit Manual, 1979.
5. S.Eidelman *et al.,phys. Lett*. B592, 1 (2004).
6. N N Kalmykov *Nucl.Phys.Proc.Supl*. 52B 17(1997).
7. K.Werner, F M Liu and T Pierog *Phys. Rev*. C 74 044902 (2006).

How to cite this article:

Parmanand Prasad Arya.2018, Investigation of A New Technique For Separating Simultaniously Produced Scintillation And Cherenkov Radiation. *Int J Recent Sci Res.* 9(3), pp. 25251-25253. DOI: http://dx.doi.org/10.24327/ijrsr.2018.0903.1824

****