Appendix Pulse Shape Discrimination (PSD)

In the electronic circuit of the Stilbene neutron detector, Pulse shape discrimination (PSD) is employed in order to discriminate neutrons and gamma-rays. Pulse shape discrimination is a name given to a process that different pulses produced by different types of particles in the same detector. Here, the method of PSD for neutrons and gamma-ray will be discussed.

Measurement of the amount of light produced in organic scintillators by neutrons and gamma-rays shows that both the differential and integral light intensities are different as functions of time. Figure A.1 illustrates this point, which is presented by Kuchinr and Lynch [1]. It is obvious that the pulses from neutrons and gamma-rays have different

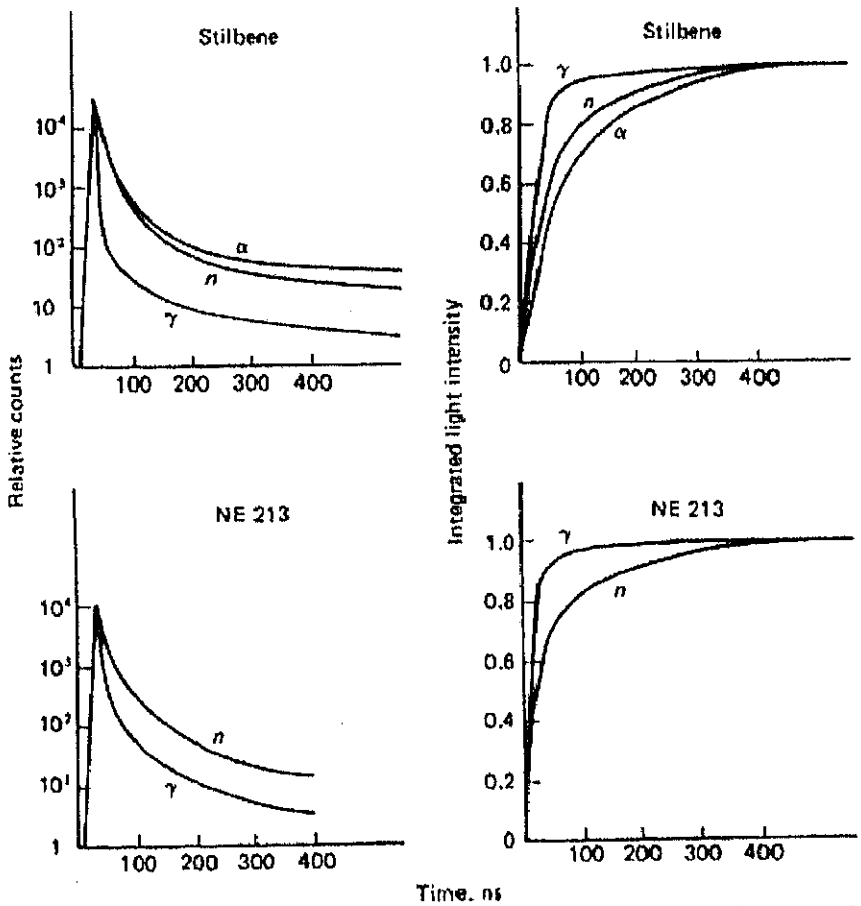

Figure A.1 The light produced by neutrons and gamma-rays in Stilbene and NE213. Light intensity is shown at left: integrated light intensity is shown at light (based on data of Ref.[1]

time characteristics, and it is this property that is used as the basis for PSD.

Many different methods have been proposed and used for successful PSD. One mehod doubly differentiates the detector pulse, either using CR circuits or a delay line, and bases the PSD on the time interval between the beginning of the pulse and the zero crossing point. This time interval, which is essentially independent of pulse amplitude but depends on the pulse shape, is usually converted into a pulse by means of a TAC (time-to-amplitude converter). The pulse from the TAC may be used to gate the couting system [2].

A second method, introduced by Brooks [3], integrated the change from the early part of the pulse and compares it to the total charge. A third method, introduced by Kinbara and Kumahara [4], differentinates neutron-gamma pulses by a measurement of the rise time of the pulse. A final example of a PSD technique is that used by Burrus and Verbinski [5], based on a design by Forte [6]. This PSD method produces a large positive pulse output for neutrons and a small positive or a large negative pulse for gamma-rays. For the Stilbene neutron detector, a second method above is employed. Since this PSD method compares integrated the change from the early part of the pulse and the total charge by using two integrators, two pulses are necessary for PSD. Therefore the signals of Anode and last dynode are used in the electronic circuit of Stilbene neutron detector.

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