Development of Hex-Zero Cross over Module for CsI(Tl) Detector

R. Kujur[1*] and A. Parui[1]
[1]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*

Introduction

The observed yield from organic and inorganic scintillator has a prompt components with decay constant ∼ns and also a slow components with decay constant few hundreds of ns in some case. The slow component of the light yield depends on the nature of the interacting particle with the scintillating medium. Exploiting this property, the particles depositing same energy in the scintllator can be identified by the pulse shape discrimination(PSD) method. Generally electronic pulse shape discrimination methods are of three types: (a) Sensing the differences in the decay times of pulses produced by preamplifier/Photo multiplier tube, (b) Integrating the pulse charge over different time constants and (c) digital capture and shape analysis of the pulses. In the rise time or crossover method the individual pulse passes through a shaping network cum amplifier producing a bipolar pulse. The zero-crossing of this pulse is a function of the pulse shape and pulse decay time. The time difference between the start pulse (generated using CFD) and zero-crossover pulse is converted to a pulse amplitude using time to amplitude converter (TAC).

The indigenous development of a six channels ZCT (Hex-ZCT) module and its test results is described in this paper. The Hex-ZCT was used in an exclusive experiment where alpha particles measured using CsI(Tl) detectors by ZCT technique [1].

Design of the ZCT module

A basic block diagram of the ZCT modue is explined in FIG. 1. The positive (+ve) lobe of

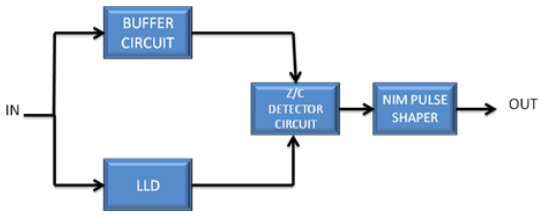

FIG. 1: Basic block diagram of the zero cross over time (ZCT) module

the bipolar signal from the shaping amplifier is compared with a variable lower level discriminator (threshold voltage). If the input signal is above the threshold level, a rectangular pulse is generated to arm the zero cross comparator. Whenever the zero cross occurs in coincidence with the arming signal the Z/C detector gives an output that is shaped to fast NIM signal. Threshold voltage set is required

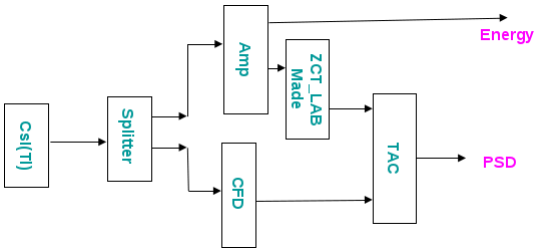

FIG. 2: Typical block diagram for pulse shape discrimination using in-house made ZCT module

to reject noise pulses. The zero-crossing time is dependent on the decay time of the input pulse and not on the amplitude. The output of Z/C is used as a stop signal for the TAC. The time difference between the start signal (from CFD) and stop signal (from Z/C detector) is proportional to the decay time of the input pulse and hence proportional to the

*Electronic address: kujur@barc.gov.in

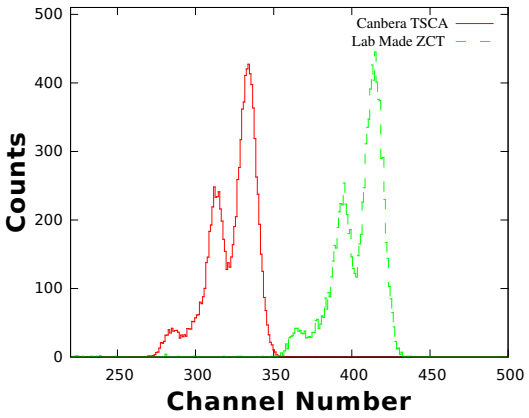

FIG. 3: A comparison of ZCT spectra using the lab made module with that of the commercially available Canbera Timing Single channel analyser in ^{7}Li induced reaction on ^{197}Au target.

pulse height of the TAC.

Test experiment and Results

The signal from the CsI(Tl) detector was split in to two, one send to the amplifier followed by the ZCT module for PSD while other part send to the CFD for the generation of the start signal. The typical block diagram used for the measurement of the PSD and energy of the particles is shown in FIG. 2. In a test experiment, the in-house developed ZCT module compared with the commercial one (Canbera TSCA). The experiment was performed at the Mumbai Pelletron Linac Facility using 30 MeV, ^{7}Li beam on ^{197}Au and Parameters PSD, energy are recorded in an event-by event mode with LAMPS data acquisition system [2]. FiG 3 shows that the alpha particles are well separated from the ^{7}Li. A factor, figure of merit (M), is used to quantify the separation between particles at given energy and defined as the ratio of peak separation between the pulses to the sum of the full width at half maxima (FWHMs). It has been found that the M value achieved with the in-house made ZCT module is 0.85 while commercial one is 0.93. The ZCT module was used in an exclusive measurement of neutron and alpha particles with excellent performance.

Acknowledgments

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References

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[2] www.tifr.res.in/~pell/lamps.html