Pulse risetime correlation studies for two fold clover detector using standard GSI Multi-Branch System

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Pulse Shape Analysis (PSA) will be the heart of the next generation gamma arrays. It gives the precise measurement of the gamma interaction point inside the germanium detector volume . PSA provides the correlation between position of interactions with the transit time of charge carriers. Such correlation studies have been performed for two fold clover detector using the standard GSI Multi-Branch System along with GSI Object Oriented On-line-Offline Go4 software.

1. Introduction

A high resolution γ-ray spectroscopy will be employed to investigate the nucleus far away from the line of stability. The drip line nuclei are produced by Radioactive Ion Beam (RIB) through a suitable nuclear reaction. Such nuclei have production cross sections down to hundreds of nano barns. Their detection is greately influenced by large atomic background with a production cross section of few kilo barn. Currently there are two major ongoing projects namely AGATA[1] array in Europe and GRETINA[2] array in USA which are under development to enhance the overall detection efficiency. These arrays will use highly segmented composite germanium detectors which will be based on PSA and Compton kinematics. PSA can be used to find out the position of interaction inside the germanium volume. Once the γ-ray position is found out then the whole gamma ray trajectory can be reconstructed using gamma ray tracking algorithms[3].

The risetime correlation of different signals of a clover detector have been studied using TIFR two fold clover detector along with GSI VME based Multi-Branch Data AcQuisition system (DAQ). The VME based DAQ was installed at University of Delhi[4] and Multi Branching System (MBS) developed at GSI was used to record the data.

2. Collimator Arrangement

A two fold clover detector has been used to store the germanium traces on event-by-event basis. It has four energy (core) signals from each crystal and three position signals namely left, middle and right[5] with respect to the target side. A lead block having dimensions of 28mm x 28mm x 22mm has been used to collimate ^{137}Cs 662 keV gamma line. The block has a 2mm diameter hole at co-ordinate (-11mm,11mm) with respect to the centre of block. It was placed at a distance of 10mm from the detector surface. The central co-ordinates of the lead block were at (-14mm,14mm) with respect to the centre of clover detector.

3. Data Acquisition

The conventional Nuclear Instrumentation, NIM modules and Versa Module Europa (VME) electronics have been used to process the electrical signals. A total of 11 electrical signals were processed through NIM and

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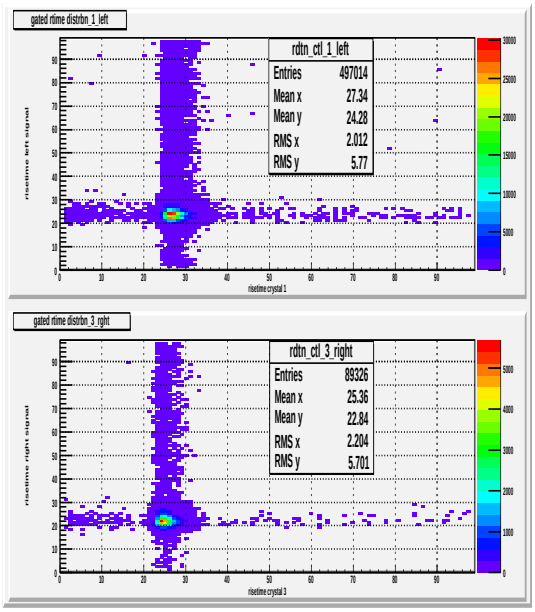

FIG. 1: density plot of risetimes of first with left (Top) and third with right (bottom) signals plotted on x and y-axis respectively

VME crate. These signals consist of 4 energy, 4 timing and 3 position signals respectively. The four individual timing gates were generated using Constant Fraction Discriminator and Gate Generator. An OR NIM signal of the four individual timing gates has been used to generate the raw trigger. GSI based trigger module TRIVA5 [6] has been used in the acquisition[4]. It delivers accepted trigger for the acquisition. The preamplifier energy and position pulses were processed through a 16 bit VME SIS3302 flash ADC digitizer from struck [7]. The flash ADC was operated under 100MHz sampling frequency with a decay time of 50 μs and 500 trace points. The gate width of the accepted trigger was kept to be 300ns to accomodate all the preamplifier pulses. The standard GSI Multi-Branch System MBS [8] version 5.0 has been used for readout of all the 7 channels with both the trace and pulse height information. MBS works under Lynx real time operative system in an embedded VME PowerCPU platform RIO4. The average data transfer rate was observed to be 9 MB/sec. The energy traces and respective histograms of SIS3302 digitizer were visualized and analysed by the standard GSI Object Oriented On-line-Offline Go4 software [9]. The Go4 analysis framework is based on ROOT [10] package of CERN.

4. Data Analysis

Clover detector traces were analysed offline using Go4 based analysis software [11]. All the channels fired under good event condition were collected. The pulses were further collected under photopeak condition. They are normalized with respect to the resolution of the crystal and time aligned at 1/5'th of the pulse height towards 150^{th} bin no. The density plot of risetime for first crystal with left traces and third crystal with right traces is shown in Fig.1. Further analysis is in progress.

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