TIFR Digital Data Acquisition Software for Nuclear Structure Studies (TIDES)

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Introduction

The high spin states of neutron deficient and stable isotopes remain a topic of significant interest in nuclear structure research. Heavy-ion fusion evaporation reactions are used to populate the high-spin states of these nuclei. Different exotic nuclei with quite low cross-sections can be populated in the charged particle emission channel. Large array of Compton suppressed High-Purity Germanium (HPGe) clover detectors coupled to a 4π-charged particle detector array will be an efficient tool to study isotopes produced with low cross-sections through charged particle emission channels [1]. For studying long lived nuclear states *i.e.,* nuclear isomers, the ancillary detector $LaBr_3$(Ce) are being used generally due their good time resolution [2]. There is a plan to couple 16 $LaBr_3$(Ce) and 84 CsI(Tl) detectors to Indian National Gamma Array(INGA). For coupling all ancillary detectors to INGA, we need to upgrade existing Digital Data Acquisition system [3]. A root based multi-threaded software has been developed to control and acquire data from PIXIE-16 DGF from XIA for the hybrid configuration with 100 MHz, 250 MHz and 500 MHz cards for clovers coupled with different type of ancillary detectors with slow and fast signals.

TIFR Digital Data Acquisition Software for Nuclear Structure Studies (TIDES) is designed and developed to control data acquisition(DAQ) system and acquire data for gamma-ray spectroscopy. The hardware is XIA based PIXIE 16 system. It permits acquisition at a very high count rate with digital pulse processing (DPP) on a field programmable gate array (FPGA) performing pulse height analysis (PHA), pulse shape discrimination (PSD) and pile-up rejection (PUR) algorithms. This paper presents the implementation of the software and overview of the results obtained in different experiment using TIDES.

DDAQ algorithm and software architecture

This digital DAQ system has the provision to handle up to 96 channels for 24 Compton suppressed clovers coupled with 4π charged particle detector array consisting of 96 CsI(Tl) detectors and 16 - 32 $LaBr_3$ (Ce) detectors. The Pixie-16 custom firmware will generate trigger for one or two or higher fold coincidence for Compton suppressed clovers in coincidence with one or higher fold of ancillary detectors.

TIDES is written in C and C++ under CentOS linux using ROOT libraries from CERN. Dynamically linked ROOT libraries are used to implement the various windows and subwindows, tabs and widgets - buttons, text or number input and output and display boxes, store histogram data and display histogram on screen etc. It has the standard X-window software architecture using dynamically linked ROOT libraries to implement the GUI and also do data display. Some basic analysis like gain calibration and finding peaks in histograms *etc.* can also be done. The main

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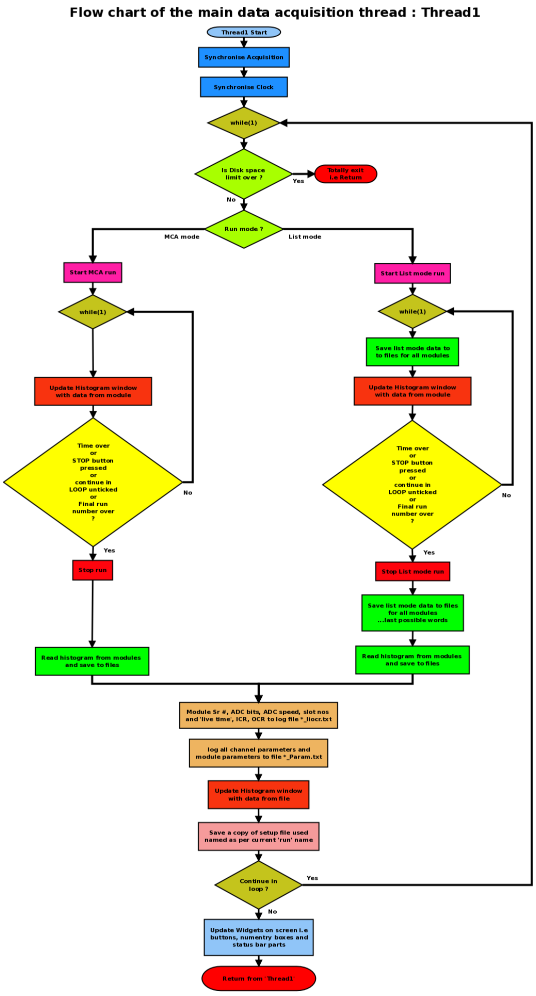

FIG. 1: Flow chart of TIDES .

GUI user window actions are taken care of by the main program where as the data acquisition, storage and display is taken care of by a spawned thread named 'Thread1'. This thread communicates with the main program using global variables to give various information and also to take actions as per user commands. The various main function blocks of the DAQ 'Thread1' are as per the flow chart in (Fig. 1). Here is one branch for the 'MCA' mode and another for the 'listmode'.

Results and Discussion

We have performed many experiments online as well as offline measurement using TIDES. Typical particle identification (PID) curve obtained in an experiment using heavy ion fusion-evaporation reaction with ^{82}Se target and ^{13}C beam at E_{lab}=60 MeV to populate high-pin state in ^{90}Zr nucleus is depicted in Fig. 2.

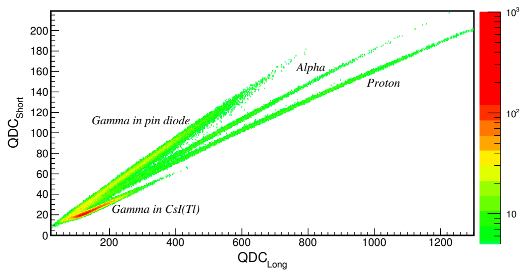

FIG. 2: PID curve showing α, proton and gamma observed in the experiment.

References

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