Digital Pulse Processing and DAQ System for INGA at VECC

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Introduction

The Indian National Gamma Array (INGA) has been the principal tool for nuclear structure studies in the country for almost two decades now. The setup has evolved through different campaigns and has been closely accompanied by several developmental endeavours at the contributing institutes. Currently, the setup is virtued with (i) geometries that can accommodate as many as 24 Compton suppressed Clover detectors amounting to a total photopeak efficiency of $\sim$ 5% (1), (ii) compact pulse processing electronics in the analog (1) and the digital domains (2), (iii) data acquisition systems and supporting softwares that are capable of handling substantial event rates and (iv) programs for processing and analyzing the acquired data and all of these, most importantly, largely developed within the national community. The present campaign of INGA is being housed simultaneously at the Inter University Accelerator Centre (IUAC), New Delhi and the Variable Energy Cyclotron Centre (VECC), Kolkata. The Room Temperature Cyclotron (RTC) at VECC, quite uniquely, is providing α and proton beams at $\sim$ 7-10 MeV/nucleon that befits low spin nuclear structure studies, through horizontal/non-yrast spectroscopy. The α and proton induced reactions are typically merited with few (one or two) reaction channels that take up the entire cross section and results into a statistical leverage in their yields. This eventually facilitate unambiguous conclusions on the level structure of the nuclei of interest, particularly in the domain of low excitation energy and spin, and is being pursued in different experiments carried out using the setup.

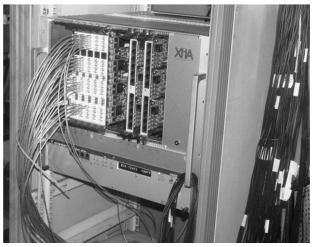

FIG. 1: Digitizer based pulse processing and data acquisition system of UGC-DAE CSR, Kolkata Centre being used at the INGA setup in VECC.

INGA Setup at VECC

The INGA at VECC is constituted with 6-7 Compton suppressed Clover detectors distributed at angles 125^o, 90^o and 40^o. In addition, the setup also houses a LEPS detector for X-rays and low energy γ-rays detection. The pulse processing and data acquisi-

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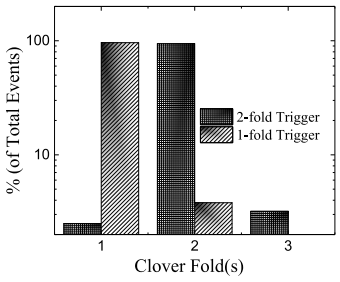

FIG. 2: Typical multiplicity profile of events acquired with the digital DAQ in the INGA campaign at VECC. While the profiles are different in case of 1-fold and 2-fold triggers, the rate of 2-fold events is similar and can be perceived as a virtue of the present digital system working under Compton suppressed detector multiplicity trigger.

tion system is a digital one, the firmware of which has been conceived at the UGC-DAE CSR, Kolkata Centre and the system has been manufactured by XIA LLC (USA). The principal components of the system are 12-bit, 250-MHz, 16-channel PIXIE digitizers housed in a PXI crate and controlled by a supporting software running on the host computer that communicates with the crate through PCI-PXI interface via fibre optic cable. The operation of the system is a triggered one and the same is generated from a (user) chosen multiplicity of Compton suppressed Clover detectors. This is similar to the methodology conventionally practised with the analog electronics at the multi-Clover arrays but now merited with the fast processing vantage of digital processing. The pulse processing for Compton suppression and generation of multiplicity trigger, as practiced in the analog circuitry, has been implemented in the present digital system. This is apparently at variance with the popular "triggerless"philosophy usually adopted for digital operation, owing to the fast processing that it offers. In such practice, one records all the detections in the (list mode) data and relies on the offline procedures for validating the events of interest. The rationale for the deviation in the present case has been the inutile nature of the Compton scattered data, presumably acquired from the Anti Compton Shield (ACS) detectors, apart from increasing the data volume and consequently loading the memory space and the data processing exercise. The virtue of the triggered philosophy adopted here is largely illustrated by the fact that it has been possible to acquire data with this system running under an event trigger generated from the firing of any single Compton-suppressed detector (multiplicity=1) without loosing 2-fold coincidence rate therein. Such singles acquisition, without loosing the coincidence rate, is impossible in the analog domain. A typical profile of events under different multiplicity trigger condition is illustrated in Fig. 2. The acquired list mode data from the present digital DAQ is processed with the IUCPIX (3) package developed at the UGC-DAE CSR, Kolkata Centre and analyzed using the standard codes. Around 15 experiments have been carried out in the first phase of the campaign by different user groups across the country. These have addressed nuclei in varied mass regions and have probed a multitude of structural phenomena therein. Data analysis of these experiments is in progress and expected to produce results of significance in nuclear structure research.

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