The Digital Highway to Nuclear Excitations: Of Milestones Covered & the Miles Ahead

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The Indian National Gamma Array (INGA) has been the main workhorse for endeavours pertaining to in-beam gamma ray spectroscopy within the country for over two decades. The facility has ushered extensive and unique developments both in the domains of electronics and date acquisition systems along with the advances in data sorting and analysis. A major landmark in the context of INGA has been the use of Digital Signal Processing based electronics and data acquisition system. The current presentation aims at discussing the results from the recently concluded campaign of INGA at VECC, wherein the digital DAQ developed by the UGC DAE CSR KC group has been used. The results from this campaign are expected to amplify the power of the system, which to the best of our knowledge is one of it's maiden kind in the context of implementing the DSP algorithms for gamma rays spectroscopy.

1. Preamble

INGA, a multi clover array conceptualized and made operational as a collaboration with the Universities and the Institutes in early 2000, has ushered in an entire new generation of practicing gamma ray experimentalists within the country. The riveting feature of this collaboration is the plethora of developments both in the filed of hardware (electronics and data acquisition systems) and software (data sorting and processing algorithms) which complemented the power and sensitivity of the measurements carried out using this facility.

The climatrics being the development of the integrated Clover electronics, followed by the use of digitizers for pulse processing in various INGA campaign. It was alluring to render the selectively provided by the conventional NIM electronics into the digital domain, preserving the vantage of the latter.

A digitizer based pulse processing and data acquisition system [1] based on Compton suppressed multiplicity trigger, has been conceptualized at UGC-DAE CSR, Kolkata Centre, for use in the gamma-ray experiments, which was presented by R Raut [2] in the context of its use in the INGA campaign at VECC. This presentation aims to highlight some of the recent developments and the results obtained from the Digital INGA@VECC campaign.

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2. Digital INGA at VECC

The campaign of INGA at VECC employed around 8 clover detectors, with two LEPS (Fig. I) being used in some of the experiments. The availability of lights (alpha and proton beams) from the Room Temperature Cyclotron at VECC, provided a unique access to non-yrast structures, and investigate intriguing phenomena in this domain.

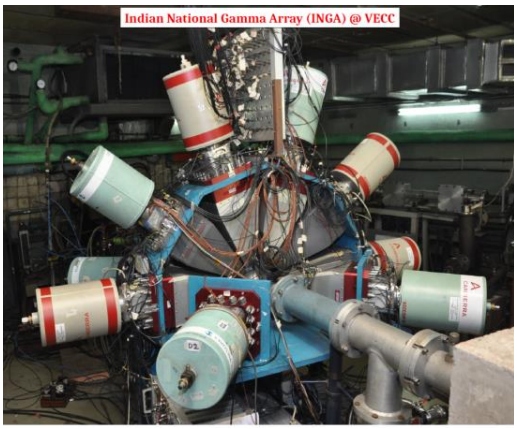

Fig I : INGA at VECC

The pulse processing and data acquisition system (DAQ), contributed by the Kolkata Centre for the campaign, was based on PIXIE-16 250 MHz 12-bit digitizers, manufactured by XIA LLC, with firmware wherein the attempt was

successfully made to port the NIM philosophy into the DSP domain was conceptualized by the in house group.

The IUCPIX [1] package, developed for processing the acquired data, with its continuous upgrades and modifications results in an expeditious reduction of the time stamped data so as to efficiently arrive upon the physics conclusions. The software has features for sorting the data into matrixes with higher dimensions, besides the formation of prompt-delayed matrices which are of relevance in isomer identification to name a few. The results presented by various groups in the present Conference, provides a yardstick for the success of the digitizer based DAQ, while some of these are briefly highlighted below.

3. Results from INGA@ VECC

The facility to be acquire data in the singles mode without compromising on any of the operational parameters both on the machine as well as the DAQ has allowed the users to study the angular distribution of the de-exciting gamma rays which uniquely elucidate the multipolarity of the transitions. These results when combined with the linear polarization measurements help us unambiguously assign the electromagnetic nature to the gamma-rays.

The use of alpha beams allowed us to investigate the low lying non-yrast states in ^{114}Te [3]. This study has helped establish a gamma-band in this nucleus. The theoretical calculations corroborate this observation.

The transitional nucleus ^{131}Xe is unique in the sense that it can only be populated in a light ion induced reaction. The recent study of this nucleus by the VECC group, has resulted in a substantial new information on its level structure owing to the observations of more than 60 new transitions [4]. Attempts have been made to identify the underlying microscopic configurations of the observed sequences.

Bisoi *et al.*[3] have successfully carried out lifetime measurements in ^{49}V, using the ^{48}Ti(^{4}He, 2np)^{49}V reaction at an incident energy of 48 MeV. This endeavour establishes the feasibility of undertaking lifetime measurements using light ion beam and thick targets using the DSAM. The results would help constrain the large basis shell model calculations.

The campaign was furthered with the availability of ^{20}Ne beams from VECC RTC. The same was used to populate excited states in ^{183}Au, (Ref. S Nandi *et al*, in this Symposium] following the ^{169}Tm(^{20}Ne,6n)^{183}Au reaction at 146 MeV. The study has indicated the possibility of the presence of rotational bands along with their signature partners. The detailed analysis of the observed angular coincidence anisotropy and linear polarization measurements, are expected to provide us with an insight into the mechanism for the generation of the angular momentum in this deformed nucleus.

Some of these results along with the road ahead shall be elaborated during the Symposium.

Acknowledgments

The members of the Nuclear Physics Group at the UGC-DAE CSR, who have contributed in the various activities pertaining to development of the digital daq are Dr. A. K. Sinha, Dr. S. S. Ghugre, Dr. R. Raut, Mr. S. Das, Mr. S. Samanta, Mr. S. Chatterjee and Mr. K. Basu. The architect of the entire hardware platform is Dr. H. Tan of XIA LLC (USA). Help received from the INGA collaboration is acknowledged. The support of the staff members associated with cyclotron operation, the target laboratory and the health physics unit at VECC, during the experiments, is deeply appreciated. Some of the developments have been fuelled by the persistent inputs from the inputs from the user community.

References

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