New VME based Data Acquisition Systems for Nuclear physics experiments at Inter University Accelerator Centre .

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Introduction

The new VME based data acquisition system have been designed and developed to fullfil the need of the Nuclear physics experimental setups at IUAC using commercial analog to digital converters (ADC), time to digital converter (TDC), Scalar, charge to digital converter (QDC) etc., along with the in-house developed DAQ software, the VME crate controller module and the event identifier module.

As the demand for high resolution and the data handling of large number of signals along with maximising the throughput are the key requirements in the nuclear physics experiments. This raises the need for high density, complex and compact modules for charge, time and energy measurements. A 21 slot VME crate may handle arround 500/1000 parameters in a data acquision setup. The VME based DAQ provides high throughput, high speed readout (110ns read) thereby achieving very less dead time as compared to the CAMAC based data acquisition systems. Due to high throughput, compactness and the ease of availability of commercial slave modules we opted for the VME based data acquision setup for IUAC at present.

Fig. 1 *VME DAQ setup a) HIRA b) INGA*

A glimpse of the DAQ setups@IUAC

The VME based DAQ have been installed in HIRA, HYRA, NAND, GPSC, INGA, GDA nuclear physics facilities along with, Atomic physics and LEIBF facilities. To serve the need of wide application areas, where high reliability, accuracy and high speed are desired, different types of slave modules are used. Like for gamma spectroscopy, high resolution 13 bit MADCs are used in high resolution mode with the conversion period not less than 14us (12.8us in data sheet) to achieve the max hi-resolution, where as in HIRA / HYRA the same MADCs are used in 13 bit low resolution mode with conversion time of 9us, to reduce the dead time. For NAND, GPSC, Atomic physics and LEIBF facilities 12bit resolution ADC are sufficient so CAEN’s V785 have been used along with CAEN TDC V775, Scalar V830 and QDC V792.

To acquire a meaningful event from a master trigger of the experimental setup, the acquisition should provide apt time for conversion and readout. This requires a roboast busy logic that works seamlessly even at very high input rates. In our case the busy logic is implemented inside the VME crate controller to take care of the dead time requirements of the DAQ modules like ADC, TDC, QDC and scaler etc., along with readout time delay and provides the second level trigger of the accepted events, as per dead time requirements for all the slave modules. The strobe width and conversion time of the second level trigger are configurable settings in the GUI of the DAQ software to ensure max data rates as per used DAQ modules. As all the slave modules are getting the gate / strobe from the same source i.e. the VME crate controller, all the parameters of the events are correlated which is very much required feature for NAND, GPSC, GDA, Atomic physics, LEIBF and INGA setup. A special option of individual strobe for compensating the flight path delays has been incorporated in DAQ software, in HIRA / HYRA, the target chamber to focal plane flight path delay exceeds the range of the TDC used. In the DAQ software GUI, various information are shown like number of the triggers received, accepted, along with time stamp, data rates, and event size etc.

Test and Results

To check the DAQ system’s event rate handling capability, data throughput measurements at various count rates has been taken in doubles and singles mode using a rate divider during the facility run in INGA beam line. During the same run with ^{16}O, 80 MeV beam and ^{94}Zr target, 16 clover setup multiplicity of 3, event rates up to 7.4 kE/s has been achieved with 30 µs dead time.

The percentage of accepted data depends mainly on the conversion delay and strobe width requirements i.e. dead time of the slave modules. For example in INGA the ADC from Mesytec used, requires 12.8 µs for conversion in high resolution mode along with a strobe width of 16µs @ 3us shaping. In NAND with five commercial VME slave modules of 32 channels each (160 parameters) event rate of 28.5 kE/s, with data throughput reaching 17.8 MB/sec has been achieved during the testing.

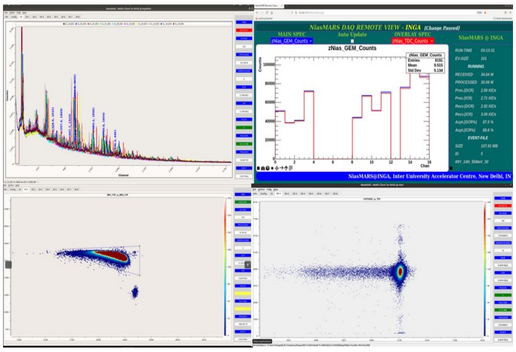

Fig. 2 *In beam experimental data a) INGA b)Webview of INGA c) NAND d) HYRA*

In present scenario the data of zero suppressed channels is being collected in ROOT format using the DAQ software, to maintain the international standards and improve the adaptability of the users. The size of the data in root format has been substantially reduced due to the data collection from only channels those are present (zero suppressed) and the ROOT compression which effectively improves the throughput.

Conclusion

The new DAQ has enabled us to move from a multi-crate CAMAC based DAQ to the single crate VME system due to use of enhanced multi-channel high density electronics like the ADCs and TDCs while multi-crate option do exist in VME crate controller. This has helped in significant reduction in space requirement and the neat cabling for the signal processing for large experimental setups.

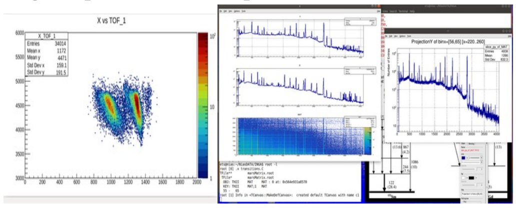

Fig. 2 *Root format data of a) HIRA b) INGA*

Further, use of VME based DAQ has allowed us to use the in-house developed analog electronics so as to achieve high time and energy resolution simultaneously. From the test results it is evident that even at event rates of 10 K per second for about 200 parameters the system can acquire 80 percent of the data for high energy resolution systems like INGA array. The system can easily handle arround 40 MB/sec of data throughput. The system also processes and display the spectra for various parameters for online monitoring of the data. The data is written in ROOT format for post-experiment analysis. The system also puts a timestamp on the data acquired with 10 ns resolution.

The VME DAQ in the current form provides us with a powerful system because of the in-built busy logic along with the large number of parameters which can be acquired simultaneously and a high event rates.

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