A novel FRS Data Acquisition

C. Nociforo[1] and N. Kurz[1]
[1]GSI, Darmstadt, Germany

In the experiments involving the use of in-flight radioactive beams the selectivity and the detection of the rare products are very demanding. Using faster processing and data acquisition (DAQ) is also important and can be crucial for the realization of those experiments that otherwise may require a non realistic beam time.

In particular, here we concern with experiments which can be performed at the GSI Fragment Separator (FRS) [1], where the count rate is limited to 10^6 pps due to an event-by-event basis detection. Depending on the reaction channel the number of parameters involved can change up to a factor 100. This is strictly connected to the used detectors and their electronics. Until now the FRS standard DAQ was working under the GSI Multi-Branch-System (MBS) [2] in the so called single event mode. The data sender is a RIO-3 CES (800MHz) processor which is located in the FRS VME crate. In this case, each event (i.e. VME ADC, TDC, QDC signals) is read out at each accepted trigger as 34 words. During this period, typically 120 μs, the DAQ is busy and any other trigger is rejected. This fixes the dead time.

Recently we have considered the use of a more efficient read out in BLock Transfer mode (BLT), which is supported by the VME Caen modules. A BLT read out of 32x34 words takes place and allows to read all events stored in the buffer (multi event mode). Whenever the buffer is empty a Bus error is generated.

Test results

This mode was recently tested online at different particle rates and compared with the standard one. The test was performed in August 2009 during the FRS000 beam time. A $^{238}U^{73+}$ beam at 750 MeV/u was delivered by the SIS18 with a spill length of 2 s. A Cu target of 90 mg/cm2 thickness was used at the entrance of the FRS to produce fragments which are then separated at the FRS mid-focal plane (S2) according their magnetic rigidity. The FRS standard equipments, i.e. scintillators, Time Projection Chambers and MUSIC detectors, were used for getting the particle identification (PID) on an event-by-event basis. The trigger was provided by the signal released by the particles counted by the scintillator and sent to the two different DAQ. The same number of VME boards were adopted in each DAQ. In particular we used ADCV795, QDCV792 and TDCV775 for detecting signals. The latter were all equally split and sent to the same number of modules. The signals of both DAQ were digitalized and registered on disk. The trigger rate was increased up to 20 kHz by varying the FRS acceptance opening the slits or increasing the intensity of the primary beam.

The two DAQ were compared on the basis of their live time, defined as the ratio between the number of the accepted and free triggers. The result is shown in Fig. 1 as a function of the particle rate. The new DAQ is more effective compared to the standard one starting from around 400 Hz. A gain factor equal to two was reached at about 4 kHz. The measured dead time at 10 kHz was equal to 48%.

The multi-event DAQ was running in stable condition giving an adequate PID. The next step will be to include the scaler Caen V830 into the new read out. Preliminary tests have given promising results.

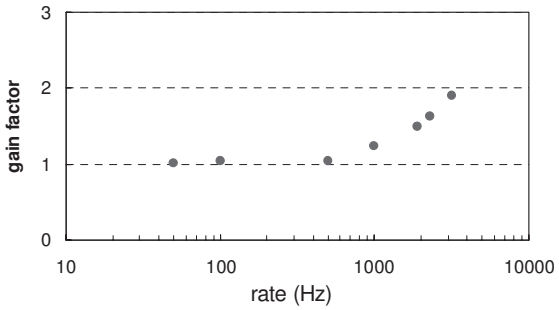

Figure 1: Gain factor of the FRS multi-event DAQ mode in respect to the standard one as a function of the particle rate.

Summary

A novel FRS DAQ based on a BLM mode was tested at the FRS. Its use can be adopted alternatively in those experiments which require the use of standard FRS equipments and an higher rate. A gain factor up to two was experimentally achieved. We would like to emphasize that this value could be still improved by using a RIO-4 CES processor. In fact another gain factor of two was already observed coupling this unit to the standard FRS single-mode DAQ. Thus in total a gain factor of approximately four may be achieved in future compared to the present situation.

References

[1] H. Geissel et al, Nucl. Inst. Meth. B 70 (1992) 286.
[2]GSI-Multi Branch System http://www.w2k.gsi.de/daq/.