Parallel Readout VME DAQ system

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We have been developing the data acquisition (DAQ) system at RIBF. The parallel readout VME DAQ system was constructed to improve the DAQ performance. The system is based on RIBFDAQ,[1)] and the data readout of all VME modules is completely parallelized by a mountable controller (MOCO).[2)] A conceptual design of the system is shown in Fig. 1. A typical VME-based system adopts a controller board to read out data from multiple VME modules, whereas this system uses MOCO together with a front-end computer: this combination acts as a readout controller to each VME module. This system was introduced in the NP1312-RIBF113 and NP1512-RIBF79R1 experiments. CAT[3)] and ESPRI[4)] detectors were installed at the F8 and F12 focal planes, respectively. The DAQ systems of both detectors worked independently, but the data of the DAQ system for beam-line detectors (beam-DAQ) were common. To synchronize absolute time information, a time-stamping system[5)] was used. After the measurements, separately taken data are merged based on time information. In this case, the live time ratio of the combined system will be worse because the dead time of each system is not shared on an event-by-event basis. The trigger rate of beam-DAQ is relatively high because the trigger signals from CAT, ESPRI and the beam-line detectors (down-scaled) were applied. Therefore, we have introduced the parallel readout VME DAQ system for the beam-line detector to minimize the dead time.

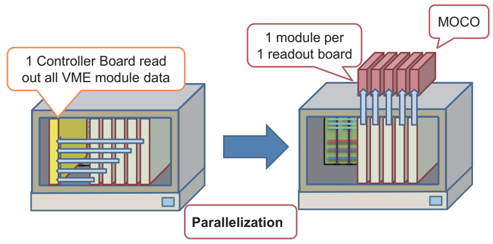

Fig. 1. Conceptual design of the system.

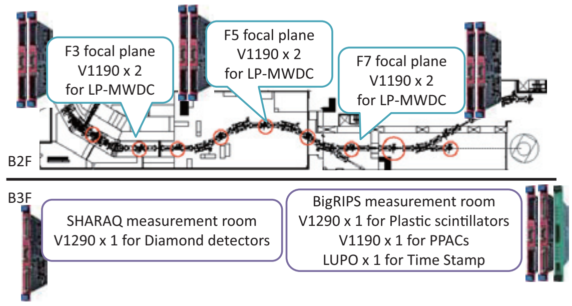

Fig. 2. VME modules for the experiments.

In the experiments, VME modules of CAEN V1190 TDC, CAEN V1290 TDC and Niki-glass LUPO[9)] were used together with MOCO as front-end systems. Figure 2 shows the installation of VME modules. As in the standard RIBFDAQ system, the dead time of each event, which is managed by a generic trigger operator (GTO),[6,7)] is determined by the slowest front-end system. The slowest one was CAEN V1190 TDC + MOCO for LP-MWDC[8)] at the F3 focal plane. Its dead time consists of the TDC time window (6 μs), the latency from the end of the TDC time window until the time when the data is ready (2 μs), and data readout time by MOCO (the number of hits $\times$ 0.2 μs). Each module's data are buffered in MOCO once, after it is acquired by a front-end computer through the USB bus. Next, the front-end computer packs data to conform to the RIBFDAQ-data format, and sends the data to the back-end system (i.e., the event builder in RIBFDAQ). If the data throughput of the front-end computer is sufficiently high, additional dead time does not occur. In these experiments, a Raspberry Pi (Version 2, Model B) which is a very cheap computer was adopted. In fact, MOCO is capable of data throughput up to 320 Mbps, but it is limited to 64 Mbps because of the limitations of Raspberry Pi. The total data rate of beam-DAQ was 22 Mbps (typically 2 Mbps per front-end system). This rate is much lower than the limitation caused by Raspberry Pi. A live-time ratio of 99% could be achieved with respect to the generated triggers.

In summary, the parallel readout VME DAQ system successfully worked with very good performance. This system was temporally installed during the NP1312-RIBF113 and NP1512-RIBF79R1 experiments. We plan to install this system for the beam-line detectors permanently.

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References

1) H. Baba et al., Nucl. Instr. Meth. A **616**, 65 (2010).
2) H. Baba et al., RIKEN Acc. Prog. Rep. **45**, ix (2012).
3) S. Ota et al., J. Radio. Nucl. Chem. **305**, 907 (2015).
4) Y. Matsuda et al., Phys. Rev. C **87**, 034614 (2013).
5) H. Baba et al., Nucl. Instr. and Meth. A **777**, 75 (2015).
6) H. Baba et al., RIKEN Acc. Prog. Rep. **46**, 213 (2013).
7) H. Baba et al., RIKEN Acc. Prog. Rep. **47**, 235 (2014).
8) H. Miya et al., Nucl. Instr. Meth. B **317**, 701 (2013).
9) H. Baba et al., RIKEN Acc. Prog. Rep. **43**, 222 (2010).