SAMURAI DAQ speed improvement

J. Gao,[*1,*3] H. Baba,[*1] M. Sasano,[*1] and L. Stuhl[*2]

In this contribution, we report the improvement of the SAMURAI DAQ speed. SAMURAI DAQ contains several VME subsystems. The typical dead time was about 200 μs. It is necessary to improve the DAQ system to acquire sufficient data for recent studies.

The accurate measurement of dead time is critical for the performance improvement. Conventionally, we estimate the typical dead time by checking the width of busy signals using an oscilloscope. However the width can be different for events with different data sizes. Therefore we developed a new method to evaluate the dead time as a function of data size using saved data. This method helps us find the device that critically limits the DAQ speed.

The data size is easy to obtain from the data file, while the dead time can be extracted from event time-stamps. Let Δt be the time interval between neighboring events (see Fig. 1). If we acquire a large amount of data, we can expect some events to be accepted immediately after the dead time is finished (like event 3 in Fig. 1).

$$dead\ time(size = s) = \inf\{\Delta t_i | size_i = s\}.$$

With pairs $(size_i, \Delta t_i)$ of each event, where $size_i$ is the data size of the device of interest for event i and Δt_i is defined in Fig. 1, we can draw a 2D histogram. For example, Fig. 2 shows two plots generated from SAMURAI30 experiment[1)] data. In this example, the histogram for the proton drift chamber (PDC) has a linear edge, but that for the beam drift chamber (BDC) appears to have a plateau on the small data size side. This implies that BDC should wait for other device(s) to finish data saving when it has a small amount of data. We conclude that PDC is the bottleneck and should be improved. We can repeat these steps to optimize DAQ performance until all devices show a linear edge on the histograms or the dead time becomes low enough for the experiment.

This method is also useful for comparing the performance of different modules. For example, Fig. 3(a) and Fig. 3(b) show the results for two widely used TDCs,

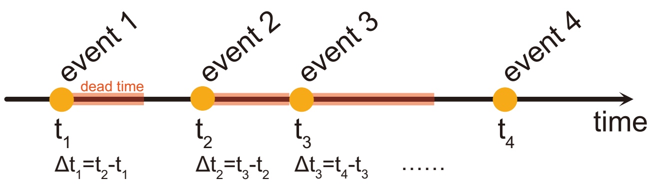
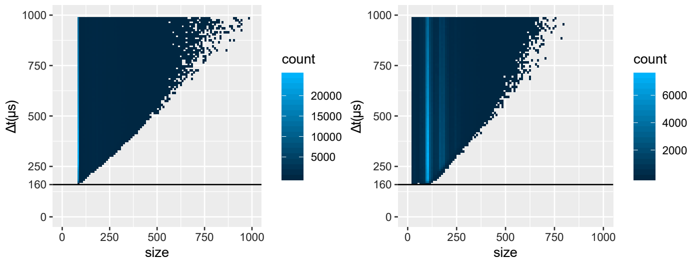


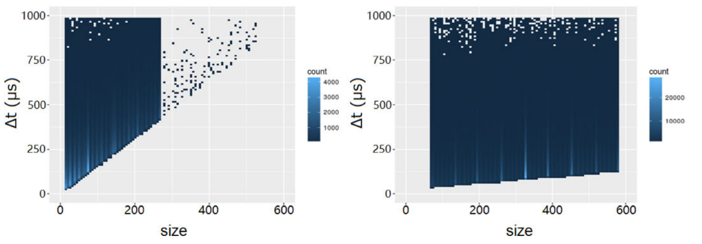
Fig. 1.: Definition of the time interval between neighboring events Δt.

[*1] RIKEN Nishina Center, Japan
[*2] Center for Nuclear Study, University of Tokyo, Japan
[*3] School of Physics, Peking University, China



(a) PDC (b) BDC

Fig. 2.: Plot of Δt versus data size for SAMURAI30 data. A comparison of the figures indicates that PDC limits the DAQ performance.



(a) AMT-VME (b) V1190

Fig. 3.: Plot of Δt versus data size for source test data. AMT-VME TDC has a larger slope, implying that its performance is worse.

AMSC AMT-VME TDC and CAEN V1190 TDC, respectively. We performed a source test for each TDC and plotted the resulting 2D histograms. The edge in the AMT-VME's histogram exhibits a sharper slope, which implies that the dead time of this module quickly increases when the data size increases. We emphasize here that it would be very difficult to recognize this performance difference through an oscilloscope measurement.

We applied this method to optimize DAQ for the SAMURAI 11 experiment.[2)] According to the results shown in Fig. 3, the DAQ speed was limited by the TDC modules, rather than the detectors. Therefore in the experiment, all AMT-VME TDCs were replaced by V1190 TDCs. Combined with other optimizations, such as the disabling of unnecessary TDC headers, the typical dead time in SAMURAI 11 was about 50 μs, and the accepted trigger rate was about 5 kHz. This is a large improvement over previous experiments in SAMURAI, which typically had a dead time of about 200 μs and accepted trigger rate of about 1 kHz.

(This work is funded by the China scholarship Council.)

References

1) L. Stuhl *et al.*, RIKEN Accel. Prog. Rep. **52**, 33 (2018).
2) M. Sasano *et al.*, in this report.