Zero suppression performance evaluation of GET electronics using SπRIT TPC experimental data

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Zero suppression is of great importance in acquiring data with a TPC equipped with GET electronics[1)] because of its huge data size. For example, the SπRIT TPC[2)] has 12,096 channels, which result in an event size of ∼6.7 MB without zero suppression. With the average disk writing rate observed during the first series of the SπRIT experiment, ∼60 Hz, data throughput corresponds to ∼402 MB/s.[3)]

The performance of three different types of zero suppression (two hardware and one software types) is evaluated through the software simulation of hardware zero suppression based on the observation from the experiment. Below is a brief explanation of the data structure from the GET electronics. Single channel data are composed of pairs of ADC and elapsed time from the trigger (time bucket, TB). Figure 1 shows the display of ADC-TB pairs from GET electronics. In full readout mode, ADC values are sorted sequentially so that TB information is omitted to reduce the data size. In the zero-suppression mode, however, TB information is indispensable because only some of the ADC-TB pairs are stored. As a result, the data size of a channel in the zero-suppression mode is greater than that in the full readout mode when the threshold is set to 0.

Hardware zero-suppression mode 1 writes all the ADC values in a channel above the threshold. The data size is greater than the size in the full readout mode unless the number of fired channels is less than half of the number of total channels. The mean number of fired channels of ^{132}Sn+^{124}Sn collision events is ∼6900 out of 12,096 with a threshold of 0.05% of the maximum ADC value. The data size of zero-suppression mode 1 is 114% of the full readout data size.

Mode 2 writes ADC values above the threshold only. With the same conditions as those used in mode 1, mode 2 results in merely 14% of the full readout data size. One disadvantage of this mode is that it is difficult to determine the baseline because the mode removes all the signals below the threshold.

The software zero-suppression mode we designed keeps 5 more ADC-TB pairs at every crossing point of the signal to the threshold value. For example, in Fig. 1 the largest pulse at the center cross the threshold at 90 TB and 115 TB. The software zero-suppression mode keeps not only 90∼115 TBs, but also 84∼89 and 116∼120 TBs. We also added a feature to reduce the data size using the fact that ADC-TB pairs above the threshold are not random but sequential from the point crossing the threshold. By writing the first TB of the crossing point and the number of TBs, we could make the data size 10% smaller than what it would be if we simply follow the rule of hardware zero suppression. The data size of software zero suppression is 21% of the full readout data size. Moreover, the suppression process is performed after the baseline is determined and matched to 0. However, the software zero suppression also has disadvantages in that it involves an additional process after acquiring data and consumes additional disk space for processing.

In summary, hardware zero-suppression mode 1 will be extremely useful when only a few tracks are generated. The use of zero-suppression mode 2 is efficient when the baseline determination is not a problem. The software zero suppression is more flexible but requires computational and storage resources and must be performed offline.

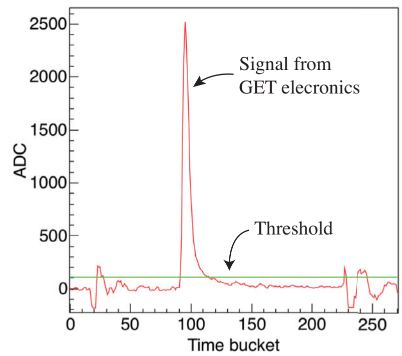

Fig. 1. Baseline-matched signal from GET electronics (red solid curve). Zero suppression mode 1 stores complete curves on the figure if there exists a part above the threshold (solid green line). On the other hand, mode 2 stores the parts above the threshold only. Software zero suppression stores 5 more ADC-TB pairs at each crossing point to the threshold.

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