Integration of GET system for SπRIT-TPC

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A Time Projection Chamber (TPC) has been produced as the main detector of the SAMURAI-SπRIT project for the study of the nuclear equation of state using heavy ion collision experiments[1]. As the readout system for the SπRIT-TPC, we have integrated the Generic Electronics for TPC (GET) system[2], which was developed mainly by a France and USA collaboration[3]. For the integration of GET electronics, development of interfaces in terms of both hardware and software are necessary.

Since the GET system was developed for general usage, the interface of the GET electronics to a TPC depends on the specifications of each detector, such as connector types and the signal characteristics of the detector, and this interface has to be developed for each project. We call such an interface a ZAP board, which serves as an adapting connector between the GET electronics and the TPC, as well as providing protection for the electronics. Thus GET electronics can be mounted on any TPC by just making the ZAP board. There are several requirements for designing the ZAP board. In the case of SπRIT-TPC, the board was designed to fit in the space on the TPC which is supposed to be installed in the SAMURAI chamber, to reduce the noise in order to increase the dynamic range, and to reduce the distortion of gain among the different channels. It is especially important to reduce noise since it strongly affects the electrical treatments of a signal. Here the electrical treatments of each signal are: 1. hit pattern register which is made by the discriminator on each signal after the pre-amplification, 2. internal trigger which is made with the hit pattern register, and 3. zero-suppression of digitized signal. The quality of the internal trigger strongly depends on noise level, which is strongly affected by the design of the ZAP board.

To satisfy our requirements, prototypes of several types of interface boards were made and the above requirements were checked quantitatively by using the minimum GET system composed of CoBo+AsAd+ZAP boards. The AsAd board is for the amplification and digitization of an analog signal[3]. The AsAd must be installed near the TPC in order to reduce noise. The CoBo board is for handling the trigger, controlling the AsAd and managing data[3].

To fit the AsAd board on the SπRIT-TPC within the limited vertical space of ∼17 cm, a prototype flexible ZAP made of a thin Cu plate (10 μm) and polymide (12.5 μm) was first made. The noise level of the flexible board, which can be estimated through RMS of pedestal, is not small. This is most likely due to the large capacitor made by the noise shield and signal line (50∼100 pF/ch). The capacitance of each signal line can be roughly calculated as a plane parallel plate capacitor. Ultimately it was decided to use a ZAP board made of conventional rigid electric board which has a short signal line and small capacitor on each signal line of 10∼20 pF/ch. The achieved noise level is 4 ADC under the configuration of a dynamic range of 12 bit, 120 fC and a shaping time of 233 nsec. It can be reduced to be 2∼3 ADC after the subtraction of a fixed noise pattern (FPN) line which is not connected to TPC pads. Without this ZAP, the GET electronics exhibit and average noise level of 3 ADC. This noise level is small enough for the SπRIT experiment, and so the production of ZAP has started and the mounting of GET electronics on the TPC is ongoing.

The user of the GET system is not only responsible for the interface to their TPC, but they must also integrate or develop the DAQ. For the SπRIT project, NARVAL[4] is planned to be employed as the DAQ system. By employing NARVAL, large amounts of data of more than 100 MByte/sec from SπRIT-TPC can be handled. The development of an interface to send data from Babirl to NARVAL is being developed so that raw data from Babirl can be merged with data from GET system by using NARVAL.

We have performed a test experiment using the GET system on another TPC with the final ZAP at HIMAC during November 2014. NARVAL was not used in this test experiment. The analysis result of the test experiment is reported by G. Jhang in this APR. In the test experiment, we took benchmark test data of the GET system. We read out 756 channels with a sampling rate of 25 MHz and 256 time buckets. A partial readout mode using the hit pattern register was used to increase the data acquisition rate as much as possible. A data acquisition rate of 600 Hz and a data rate of 1 GByte/min were achieved, which is sufficient for the first experiment of SπRIT project.

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