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Trigger System for BaF2 Detector Array Readout Electronics at CSNS-WNS

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A segmented 4π detector array that consists of 92 BaF2 crystals is being constructed for neutron capture cross-section measurement at WSNS-WNS (White Neutron Source at China Spallation Neutron Source). In order to precisely obtain the wave and time information carried by detector signals, a 12-bit ADC with sampling rate up to 1 GSPS is used for waveform digitization in the readout electronics. However, high speed digitization of 92 detector channels results in huge amount of raw data, which brings challenges for data acquisition. To decrease the data rate, a distributed trigger system based on PXIe is proposed in this paper. Moreover, a fully digital trigger system is also available because of waveform digitization. The whole readout electronics are housed in 4 PXIe chassis, making the trigger system a distributed architecture. Each chassis has a trigger and clock module located at PXIe system timing slot. One of these modules serves as the global module (GTCM) and the others as local modules (LTCMs). GTCM is the root of the trigger distribution tree. Once GTCM receives the T0 pulse signal from accelerator, it opens a time window with 10 ms width, within which signal from detector array is considered as valid. If the cascade multiplicity and the total energy of the 92 detector signals meet the requirements of trigger algorithm, a trigger signal will be generated and distributed to all LTCMs via coaxial cables with equal length. LTCMs are intermediate nodes in this distribution tree, where trigger signal is further distributed to all FDMs in the same chassis through dedicated differential star triggers on the PXIe backplane. Sub-trigger module (STM) is designed to count channels over specified threshold and add energy together of 16 analog signals fed into it. Therefore, there are 6 STMs in total for the BaF2 detector array readout electronics. They are deployed in the chassis where GTCM resides to obtain trigger information from 92 detector signals. The results of the 6 STMs will be eventually aggregated to GTCM through dedicated differential trigger bus on the backplane for trigger signal generating. Compared with traditional trigger signal distributing strategy, taking advantages of PXIe backplane resources, the number of distributing cables can be decreased drastically, which makes this structure of trigger distributing much more compact. Benefit from waveform digitization, trigger algorithm in STMs can be fulfilled in FDMs using digital data processing. The extracted trigger information will be uploaded to LTCM and then to GTCM using high-speed serial data transmission technique, making the trigger system fully digital. In addition to further simplifying the structure, digital trigger system is much more flexible for applying variable algorithms.

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