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EVENT MODE DATA ACQUISITION SYSTEM AT MLF/J-PARC

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ABSTRACT

There are several kinds of detectors, such as a ^{3}He-position sensitive detector, a scintillation detector and a gas electron multiplier type detector in the Materials and Life Science Experimental Facility (MLF) of Japan Proton Accelerator Research Complex (J-PARC). We have introduced the standard data acquisition (DAQ) system which records the neutron signal from these detectors with event by event. This event mode DAQ system is acquiring neutron detection data through the "SiTCP" interface which is the DAQ specified Ethernet interface by the "DAQ-Middleware" which is the flexible and scalable DAQ software. In the event mode DAQ system, each neutron detection event has the time of flight (TOF) and the pixel position of the neutron detectors. Making good use of this, we can extract the signal of the multi incident energy from these neutron event data after the measurement in the chopper spectrometer. In addition, our neutron event data have not only the TOF but also the clock data. And we have similarly recorded the events from the devices of the sample environment control and the beamline components with the clock. The status of the neutron source is also recorded with the clock, such as the proton current in every beam pulses, the temperature of the moderators, and so on. Using these event data with clock, we can reconstruct the data set under the various conditions after the measurement.

1. Introduction

In MLF/J-PARC, a lot of neutron experimental instruments which have groups of detectors with thousands of pixels are measuring the neutron signals. The types of the detectors are various, such as a ^{3}He-position sensitive detector (He-PSD), a scintillation detector and a gas electron multiplier (GEM) type detector according to the purpose of the instruments. We have standardized the DAQ system to record the signals detected by these detectors. We have also decided to record the signals in event by event with clock because we want to know the history of each neutron from production to detection. Thus, for example, in the case of the measurement of transient phenomena, we can reconstruct the correlation between the neutron and each phenomena recorded with clock under the various conditions after the measurement.

2. System

It is the first priority of our DAQ system that the system records the neutron detection events without fail. The second priority is that the system is scalable according to increasing the neutron intensity of MLF/J-PARC. The third priority is the standardization using commercial products to the utmost. For these purposes, we have introduced the field bus with Ethernet into our standard DAQ system shown in Fig. 1. There are two new technologies developed in KEK. One is the specified Ethernet interface which we call "SiTCP" [1]. Another is the flexible and scalable DAQ software which we call "DAQ-Middleware" [2]. The features of the SiTCP are the data transferability with almost 100Mbps full speed, the ability of implementation on 1 chip, low power and low noise. The SiTCP looks like FIFO memory from electronics and TCP server from computers. We attach the SiTCP on each our DAQ hardware [3]. The DAQ-Middleware is a software framework specified data acquisition and consists of several DAQ-Components. The DAQ-Middleware is based on Robot Technology Middleware (RTM) developed in Advanced Industrial Science and Technology [4]. The RTM is one of the Object Management Group domain specifications. We have installed the DAQ-Middleware in our DAQ computers. The DAQ-Middleware includes the function of data recording into storage as well as online monitoring. We can measure monitoring the 2D image on the detectors and TOF histogram. We can do run control our DAQ system by exchanging the messages (Begin/End/Pause/Resume) written in XML format via our software framework [5] and a web-browser.

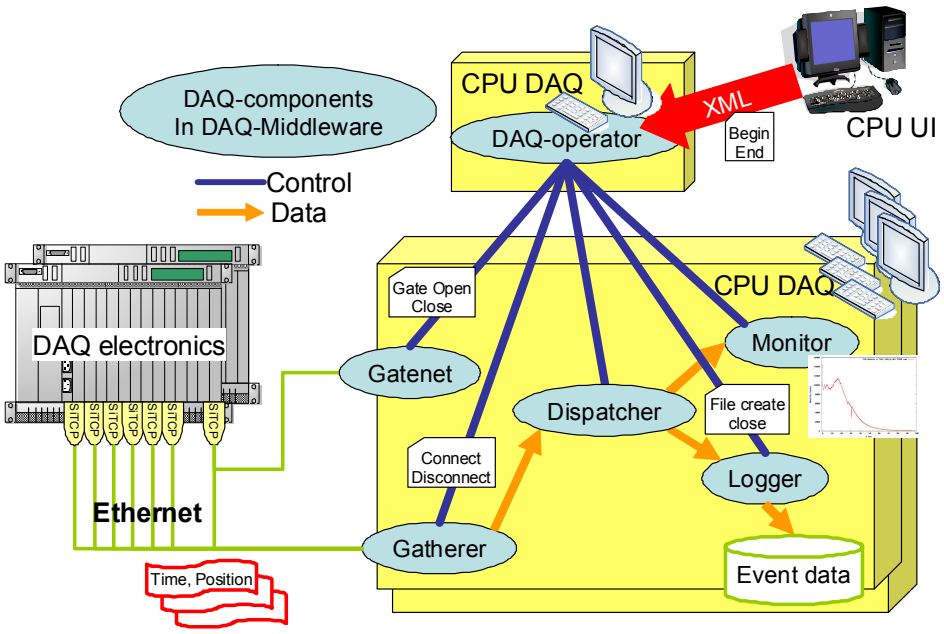

Fig.1 The schematic view of the MLF standard DAQ system

Every neutron event data includes the information of TOF and the position when and where the neutrons are detected. However, unfortunately, the event data format is different depending on the kinds of the detectors. We can do histogram in arbitrary time bin width after the measurement. In the case of He-PSD, we can also separate arbitrarily the pixel size of the PSD, for example, according to the position resolution because it includes the

pulse height values at both ends. In addition, the event data files include the information of the TOF trigger of each spallation and the clock of the instrument. We also measure the status of the devices of the sample environment and the beamline components with the clock. Furthermore, the status of the neutron source is recorded with the clock, such as the proton current in every beam pulses, the temperature and the ratio of ortho / para hydrogen of the moderators, and so on. We can recognize the correlation between the neutron detection event and these statuses. For example, we can extract the data set of various conditions in the transient phenomena.

3. Present status

There are 23 neutron beamlines in MLF/J-PARC. Now 12 instruments are in operation. Our standard DAQ system has been installed in 8 instruments shown in Table I. The number of the He-PSD type is 6, the scintillator is 2 and GEM is one. We have been grouping the DAQ system by the detector type. These are developed and maintained by each group [6, 7]. The other instruments are the original or old DAQ system in use.

Table I. The correspondence between the instruments and detectors

BL	Instruments	Detector type
01	4SEASONS	He-PSD
03	iBIX	2D Scintillator
08	SuperHRPD	He-PSD
12	HRC	He-PSD
14	AMATERAS	He-PSD
19	TAKUMI	1D Scintillator
20	iMATERIA	He-PSD
21	NOVA	He-PSD, GEM

Some applications have been already done by our event mode DAQ system. In 4SEASONS (BL01), the multi E_i measurement has been done [8]. The inelastic scattering signals excited by the neutrons of several incident energies have been able to be extracted from the data measured in one scan. This measurement is the method which makes the chopper type instruments much more efficient. It is already the standard measurement of the chopper type instruments in MLF/J-PARC. Another example, the time-slicing measurement has been demonstrated in TAKUMI (BL19) [9]. The change of the diffraction peak has been observed by heating the sample because the neutron detection events and the temperature of the sample with same clock have been measured. Thus, we can easily reconstruct the data set according to the various conditions after the measurement.

4. Summary

The event recording is standards on the DAQ system in MLF/J-PARC. We have succeeded to standardize the DAQ hardware interface and software. The event mode DAQ system has been installed to several instruments and some applications have been done. We will gradually install our DAQ system when the old DAQ system will be replaced or new instruments will be constructed.

5. References

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