

Data acquisition system for J-PARC 3GeV RCS

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ABSTRACT

For development of technologies and science utilizing a high intensity proton accelerator, JAERI and KEK are promoting a joint project "Japan Proton Accelerator Research Complex (J-PARC)". J-PARC consists of a linear accelerator (Linac), a 3GeV rapid-cycling synchrotron (RCS), and a 50GeV synchrotron (MR). Each accelerator transports high intensity beam to the experimental facilities, a materials and life science facility (MLF), a nuclear and particle physics facility, and an accelerator-driven transmutation experimental facility.

Since the RCS is a proton synchrotron with an extreme high power of 1MW, a delicate care must be taken to suppress radiation due to beam loss.

The RCS injects each beam pulse of 25 Hz into the MLF and the 50GeV MR in a predefined order. Since different beam control parameters are required for the MR and the MLF, monitoring and control must be made separately for each beam pulse, distinguishing the destination in the control system. In order to realize this demand, synchronicity of data is indispensable.

There is beam position data etc. which requires synchronicity collection (fast synchronized data and slow synchronized data). To collect such data, we will build the system which uses Reflective Memory (RM), Wave Endless Recorder (WER) and so on.

On the other hand, there is data (standard data) which requires only slow (1sec-) collection, such as the status of power supply. The slow data will be collected via a network.

Therefore, RCS Data Acquisition (DAQ) system needs to collect simultaneously three kinds of data, fast synchronized data, slow synchronized data and standard data. And, RCS DAQ system is necessary to provide a user with these kinds of data which are matched.

INTRODUCTION

The overview of RCS control system is shown in Fig.1. RCS control system mainly consists of HMI (Human Machine Interface), Components (Machines and Devices), Control Parameter

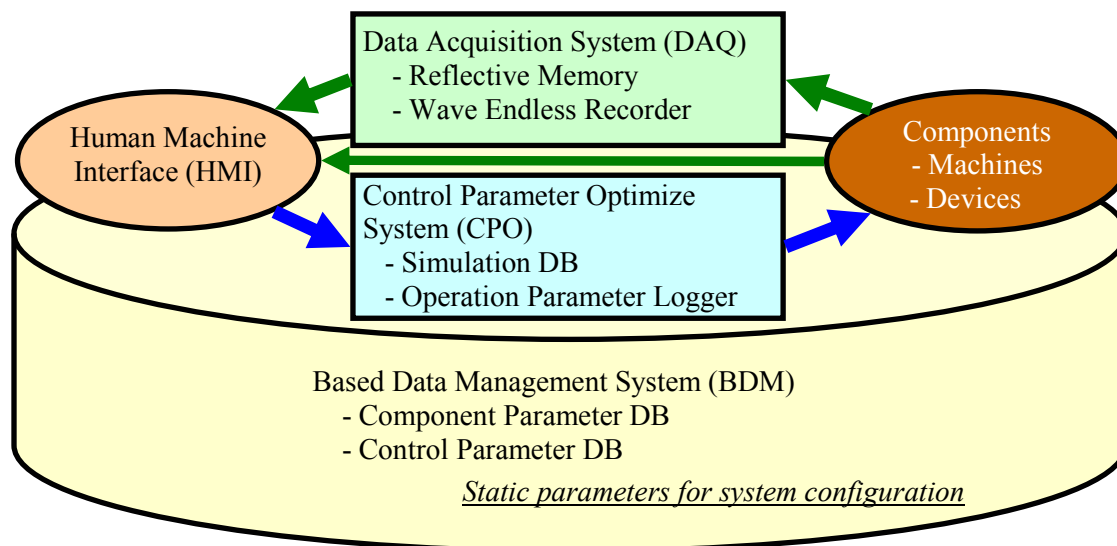


Fig.1 Overview of RCS control system

Optimize (CPO) system, Based Data Management (BDM) system and DAQ system [1].

Then, the RCS injects each beam pulse of 25 Hz into the MLF and the MR in a predefined order. Control parameters should be set differently depending on the destination [2]. So, RCS control system is required unprecedented capability to supervise correctly by distinguishing the beam for MLF and MR. Therefore, it is important that all 25Hz beams which inject different destination must be monitored distinctively in RCS DAQ system.

This paper gives the outline and the development status of 3GeV RCS DAQ system.

DAQ SYSTEM

Since different beam control parameters are required for the MR and the MLF, monitoring and control must be made distinct for each beam pulse. In order to realize this demand, synchronicity of data is indispensable. However, it is not necessarily mean that all data have to be synchronized. Because, there also are data required no synchronicity, such as the status data of power supply.

Then, we mainly classified into two kinds of data which should be collected, synchronized data and standard data. Furthermore we classified synchronized data into fast synchronized data and slow synchronized data. And we have designed and developed RCS DAQ system in response to each data.

Fast Synchronized Data

This data is required not only collecting all of 25Hz data but also monitoring in distinction to MLF or MR, such as beam position data. First, in order to realize the distinction monitoring, we decided to attach the beam information, such as beam tag, beam type, MR cycle tag and so on. However, if the collection data will be organized after inserting DB, it takes time to data processing. Therefore, it is not satisfied only by above way, for data supply to always monitoring.

Then, to realize above collecting and monitoring the fast synchronized data, we decided that RM is adopted to configure RCS DAQ system. To search the data quickly in distinction based on beam tag and so on, RM memory space is used as ring memory. So, all of fast synchronized data on RM are overwritten with new data at a constant cycle, a MR cycle or several MR cycles. In this way, when the data are required from HMI, it is able to supply MLF or MR beam data in distinction by searching MR cycle tag or beam type as keys.

Next, we have performed the bench test of DAQ system using RM [3]. In the test, we simulated the signal-processing circuit and DAQ system for position data of Beam Position Monitor (BPM). And we confirmed that the 25Hz fast synchronized data can be collected and the data distinction of MR cycle tag is possible by configuring the ring memory with the RM space.

Based on the bench test result, we decided that DAC system for Fast Synchronized is configured RM, Data Server for RM (DSR), and Interface PC. In this configuration (see also Fig.3), first, the fast synchronized data are written on RM by many machines, for example 54 BPM signal-processing circuits. Next, these data are read and collected by DSR. Then, DSR will store these data as files (data file and index file) temporary. Finally, these data stored DSR will be inserted DB when RCS is not operated, because first synchronized data volume is too huge (for example, BPM position data volume will became about 160GB per day). On the other hand, Interface PC search same beam tag data or same beam type data on RM space and supply synchronized data to HMI. So, synchronized MLF (or MR) beam data is able to be displayed on HMI. Now, especially, we are designing Interface PC which is important of the interface between HMI and RM for data monitoring.

Slow Synchronized Data

This is synchronized data that monitored at the slow cycle (about 1 second cycle or more than) or collected when operator commanded such as after accident. Therefore, it is not required collecting all of 25Hz data.

WER is designed with a circular-buffer and LAN. A circular buffer is divided to the beam size, called the circular box buffer, because J-PARC is a pulse driving machine. The box shifts by the beam trigger, and the trigger number (beam tag) is allocated to the box. To collect the synchronized data, the supervisory computer can get the synchronized data easily, since the data is managed by the beam tag. The beam tag may not coincide among measuring instruments because

we used a lot of WER. Therefore, the beam tags in all WER are made to coincide by the mechanism like NTP (Network Time Protocol) [4]. Fig.2 shows the hardware image of WER.

Then we have tested WER at the RFQ test bench at J-PRC and so on. And, we have confirmed that slow synchronized data was obtained. So, to collect the Slow Synchronized Data, we decided to adopt WER.

Now, we are designing and developing that DAC system for Slow Synchronized is configured WER and Data Server for WER (DSW). In this configuration (see also Fig.3), slow synchronized data will be made on DSW by collecting data on WER beam tag as key. Then, DSW as well as DWR will store these data temporary and insert these data to DB. Moreover, DSW will work as with Interface PC to supply these data to HMI.

On other hand, we think this way using WER is useful in getting to the data for post mortem.

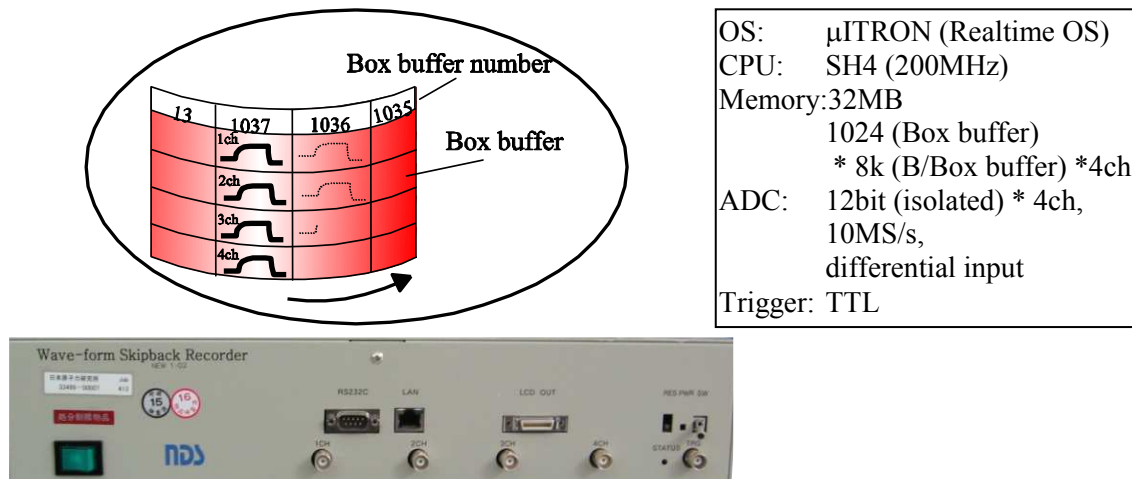


Fig.2 Hardware image of WER

Standard Data

Standard Data, such as the status of power supply, are collected when this data has changed or a constant cycle (cycle is 1 second or more than). This data will be collected via a network. Now, we are designing at the way that collects when data has changed mainly. Then the EPICS camonitor-function is used for this realization. So, these data are sent and inserted to Operation Data DB (OpeDB) after added timestamp at IOCs. The data are inserted data tables which classified according to kinds of component, for example a data table for main magnets, a data table for vacuum system and so on.

As a bench test assumed steady-state of RCS operation, we tested whether OpeDB could insert all data, which are sent from 15 IOCs and 200 ai EPICS records per IOC and second (that means, 15 * 200 ai record data are sent to OpeDB per second). This data amount in this test is more than enough, because this means 10% of all the Standard Data are changing every second (all the Standard Data in RCS is assumed about 30000 records).

In this test, OpeDB had 15 data tables and data sent from one IOC are inserted one data table. A data table has not only Value but also the other information, for example Time, EPICS record name, Status and so on. Then a data size became about 300 byte per record when inserted OpeDB, but it was no problem because OpeDB have satisfactory performance to insert data of 30000 records per second (about 0.9MB/sec = 72GB/day).

As the next step, we will test whether OpeDB have satisfactory performance responded to peak data load. We have an assumption that the peak data load is caused when machines start up same time, MPS works and soon. And we have an assumption that data amount of the peak data load will be from 25% to 50% of all RCS records per second for a few minutes (but we think this load is overrated). We will test about the peak data load in October, 2005.

Configuration and Plan

As described above, RCS DAQ system has been configured mainly in OpeDB, RM, DSR, WER, DSW and Interface PC. Fig.3 shows the configuration of RCS DAQ system. In this

configuration, we think that we got prospect of DAQ system about collecting each data. However, now, we are designing developing the way to supply each data to HMI. Then, we are focusing on designing the way to supply the synchronized data, that is, we are especially designing and developing the Interface PC.

On the other hand, on collecting each data, we plan to test by using real machines which installed sequentially at J-PARC. Then, in the way of collecting the fast synchronized data using RM, we will test at BPM signal-processing circuit whenever it is ready.

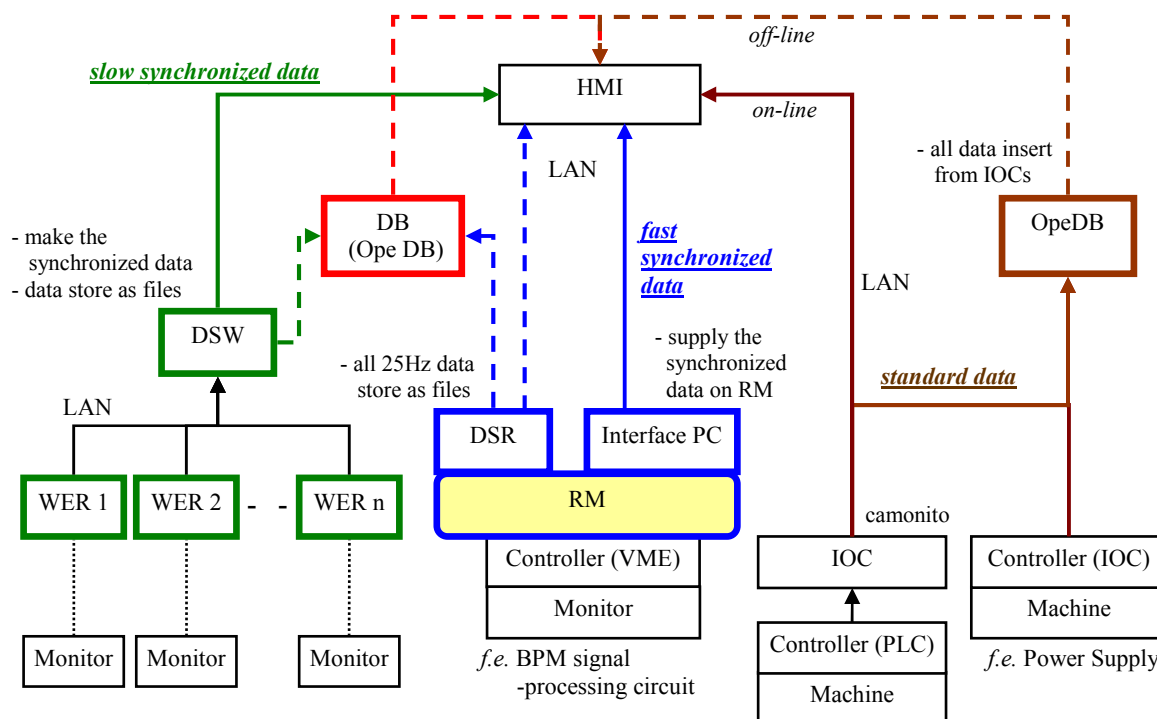


Fig.3 Configuration of RCS DAQ system

CONCLUSION

In this paper, we showed the outline and the development status of 3GeV RCS DAQ system. We designed and developed on ground that there are fast synchronized data, slow synchronized data and standard data. And, DAQ system is mainly configured with OpeDB, RM, DSR, WER, DSR and Interface PC. Then, the result of test bench and so on, we think it will be no problem for data acquisition.

Development of DAQ system go to the next step, we are designing and developing the way to supply the data in DAQ system to HMI. So, we are going to complete the DAQ system for demonstration until April, 2006.

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