DATA ARCHIVE SYSTEM FOR J-PARC MAIN RING

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Abstract

The beam commissioning of the J-PARC Main Ring started in May, 2008. A data archive system has been developed using Channel Archiver (an EPICS tool for data logging) and cadump (a tool developed by ourselves). Various machine parameters and status information have been recorded. The number of archived records exceeds 19,000 as of May, 2010.

The archived data can be retrieved in a form of graphical representation using Web-based and Java-based viewers. In addition, time-series display is available for bit-oriented information, such as interlock faults and run/stop status changes. For large waveform data of beam diagnostics signals, customised visualization tools are developed.

INTRODUCTION

The J-PARC Main Ring (hereafter MR) is a high-power proton synchrotron that boosts the beam energy to 30GeV. The beam commissioning of MR started May, 2008. Since then, various machine studies as well as beam delivery to physics experiments have been made [1].

The control system for J-PARC has been developed based on EPICS (Experimental Physics and Industrial Control System) [2], where EPICS is a toolkit for large accelerator controls developed and supported by an international community [3]. In order to record online values of MR devices during both commissioning and daily operation, we have developed a data archive system.

DATA ARCHIVE

Channel Archiver for General Signals

We introduced Channel Archiver [4], which is one of standard EPICS tools for data logging. The components of Channel Archiver are (a) Archive Engine for data logging, and (b) Archive Data Server to serve data for various data retrievers (see Section DATA RETRIEVE).

An Archive Engine watches at values of a "record", which is EPICS term to identify a signal. Various records, which correspond to signals of MR devices (power supplies, vacuum pumps, beam diagnostics, etc.), have been ready to use on EPICS IOCs (Input Output Controllers). Values are saved to files periodically at pre-defined interval, or when value changed. Data archive configurations for each record (record name, archive interval, status, etc.) are managed by web-based interface.

An Archive Data Server provides archived data to viewer clients on request. XML-RPC protocol [5] is used for data transfer over network. Use of XML-RPC protocol enables that clients can stay beyond the firewall. The overall data flow is shown in Fig.1.

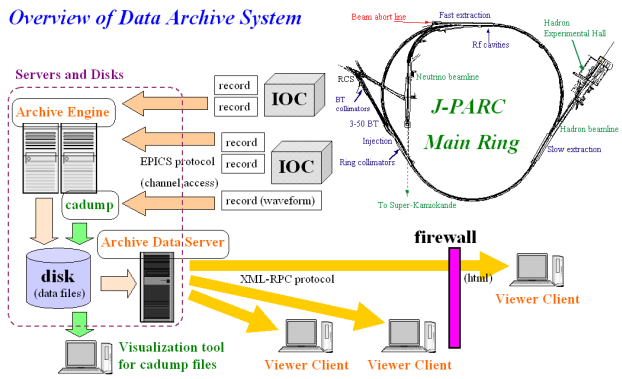

Figure 1: Overview of data archive system

We started the Channel Archiver since the end of 2007, half year before the start of MR commissioning. The number of archived records has been increased as commissioning studies have proceeded. So far, we have 30 Archive Engines (each corresponds to one data group), and the total number of records exceeds 19,000 as of May, 2010 (see Table 1).

Table 1:Major List of Archived Records

Group	No. records	Group	No. records
Utility Status	611	MR mag	2312
MR IOC Status	548	MR Fast Extract	286
MR VAC	881	3-50BT	1539
MR Commissioning	767	LINAC RFQ	8
MR PPS	422	RCS monitor	32
MR Monitor	756	Mon Complex	36
MR Injection	693	MR MWPM	495
MR MPS	731	OPR Information	43
MR Slow Extract	1148	MR Steering	3372
MR BLM	2572	MR RF	361
MR Timing	480	RCS RF	791

Cadump for Large Waveform Data

Since the machine cycle time of MR is 3-6 seconds, we have many waveform records. For example, 100kHz sampling of a signal produces a waveform record with 600k elements. Channel Archiver is not suitable for such large waveform records. In addition, Channel Archiver can not save multiple records synchronously.

Recently we have developed a new tool, cadump, which can save large waveform records together with

other reference records synchronously. Up to now, some of beam diagnostics records (DCCT, BPM) are saved to files, at every beam shot of MR. We plan to extend this scheme to other records (BLM, spill control signals of slow extraction, and so on) in the future.

DATA RETRIEVE

Web-based and Java-based Viewers

A default way to retrieve archived data is a web-based viewer. A user specifies record names and the time window of interest, after a while a graph is generated automatically (see Fig.2). This web-based viewer is easy to use even for beginners. Nowadays the viewer is used 100-200 times everyday.

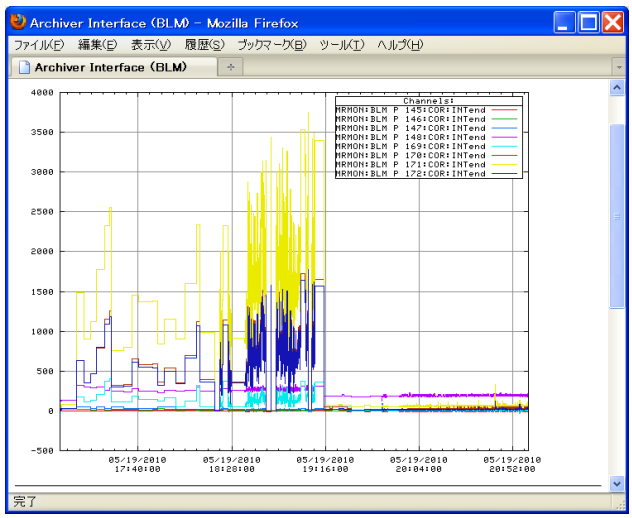

Figure 2: Web-based archive viewer (BLM trends)

A Java-based viewer has advantages over the previous one: (a) partial enlargement by mouse drag is available, (b) different Y-axes in one graphic pane is possible, (c) retrieval of records from multiple data groups is possible. An example of Java-based viewer is shown in Fig.3.

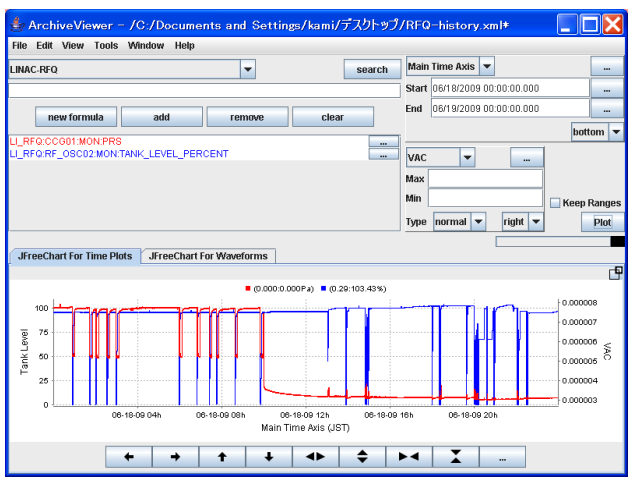

Figure 3: Java-based archive viewer (RFQ trends)

Both viewers were developed in SNS as a part of Channel Archiver toolsets [4]. Viewers were distributed in the EPICS community. We introduced them, and made small modifications to fit our site-specific environments.

Time-series Display

Command-line scripts, which generate text-based output from archived data, are also provided in the Channel Archiver toolsets. They are used mostly for maintenance of archive files.

A new scheme to generate time-series display has been developed. This is to review changes of bit-oriented records, for example run-stop status, interlock faults, etc. A web-based interface was developed, which invokes the command-line scripts and makes output lines in a time-series format. An example output is given in Fig.4.

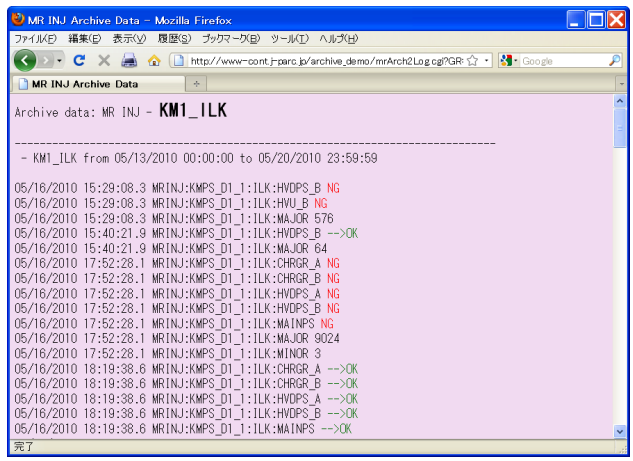

Figure 4: Time-series display (Kicker interlock faults)

Visualization of Cadump Files using HLA

Cadump data files contain complex information. Let us consider BPM records as an example. There are roughly 220 BPM locations in MR. Each BPM has X and Y signals, and each signal is recorded at 100kHz sampling rate during single MR cycle (3-6 sec.). All of these are packaged into a single file at every beam shot of MR. Thus, visualization of cadump files requires customized applications.

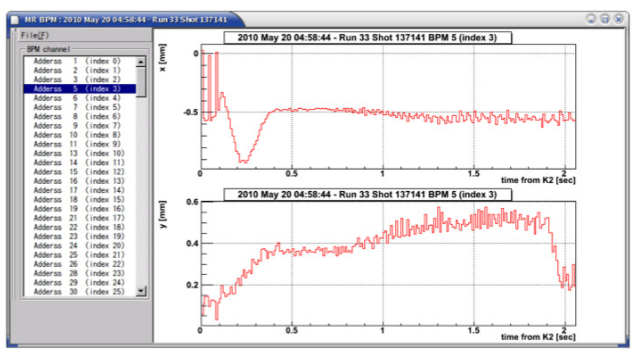

Figure 5: BPM analysis (one BPM during a MR cycle)

HLAs (High level application), such as ROOT [6] or SAD [7], are used to develop such applications. Fig.5 shows an example retrieve of one BPM (X and Y) to

make graph panels in time-domain (one MR cycle), using a ROOT environment.

DISCUSSION

Recent issue related to our Channel Archiver system is a record search system. It is not easy to find record names of interest among many data groups. A search system for record names is under development. It shows promising results.

Handlings of cadump files are not sophisticated yet. We have a few visualizing tools of cadump files for customised purposes, but no tool is available for general purposes. More study and development will be needed.

The archive system requires large amount of disk. The increase of disk usages in recent half year has been checked. Result is shown in Fig.6. Decrease of cadump data between December and March is due to the start of file compression.

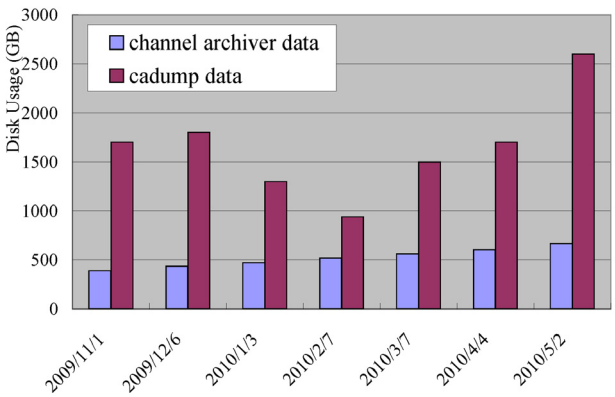

Figure 6: Increase of disk usages

CONCLUSION

Up to now, most of machine signals of J-PARC MR are recorded by our data archive system. Different types of data retrievers have been developed, and used successfully by research staff and operators. The data archive system has been understood as an indispensable tool for both in commissioning studies and in daily operations.

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