The DAQ System in RIKEN RIBF

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The new DAQ system for RIKEN RI-Beam factory (RIBF) [1] have been introduced. The schematic view of RIBF is shown in Fig. 1. Several thousands of RI-beams are produced by the fragmentation / fission reaction at the production target position. The in-flight RI-beam separator named BigRIPS [2] discriminates RI-beams by using many beam profiling detectors placed at seven focal plains along the beam line of 77-meter-long. Focal plains (detector positions) are indicated by circles on Fig. 1 Tagged RI-beams impinge on the reaction target which locates end of BigRIPS. After the reaction target, various particle / gamma-ray detectors and several spectrometers are used. The detector section of BigRIPS is used in all experiments, but the other detector section vary according to the experimental condition. Since experiments having a different setup are shifted one after another in several weeks, the DAQ system should have the flexibility. It is important to change combination of DAQ for each section as quickly as possible. Therefore, we developed a new network-distributed DAQ system. The features of RIBF DAQ are listed in follow.

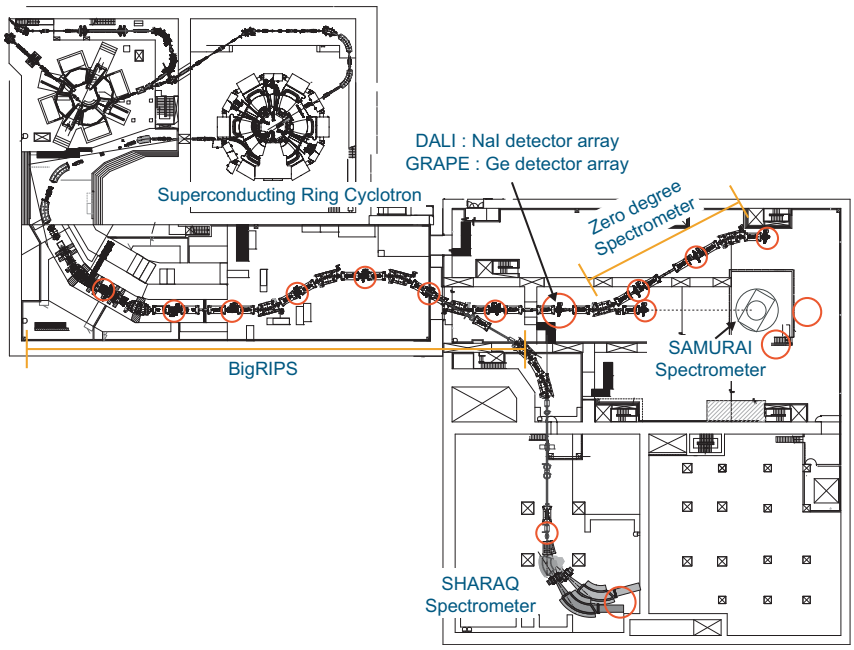

Figure 1: The schematic view of RIBF. Circles are the detector position.

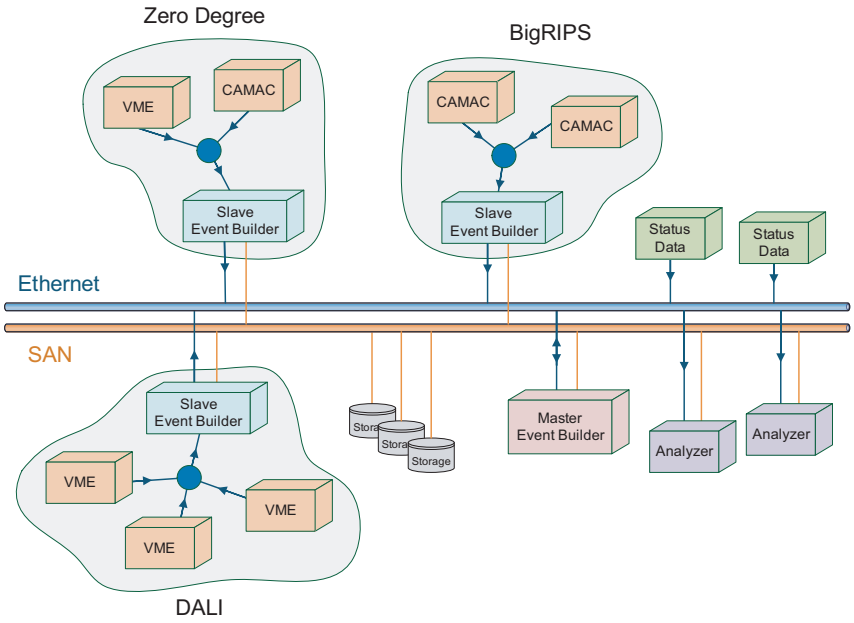

Figure 2: The configuration of RIBF DAQ. The boxes are computers. The boxes labeled CAMAC (VME) are the front-end computers for CAMAC (VME).

- Network distributed
- On-line event-build and analysis
- Hierarchical event-building
- Each detector section has each DAQ
- Parallel data readout from CAMAC, VME modules
- Commodity hardware only (PC, OS, Ethernet, RAID, SAN, etc.)

The configuration of RIBF DAQ is shown in Fig. 2. DAQ is divided into each detector section such as BigRIPS, Zero Degree, and DALI. Each detector section has own Event-Builder labeled Slave-Event-Builder in Fig. 2. Data processing is done by a software package of 'babirl DAQ' which is newly developed based on 'babarl DAQ' [3–5] previously used at RIKEN RIPS and CRIB. CAMAC and VME modules data in each crate are collected by each front-end computer in parallel. In this system, many kinds of CAMAC and VME controllers are available: TOYO CC/7700, TOYO CC/NET, Kinetic K3922, SBS 620, CAEN V2718, Wiener VMEMM, ADVME 8001, VMIVME 7700, and VMIVME 7807. Slave-Event-Builder accumulates modules data from the front-end computers, and builds event data of detector section. Then, DAQ for each detector section can work as the stand alone system. In order to construct whole event data, Master-Event-Builder receives data from Slave-Event-Builder. This data flow is the hierarchical event-building. In addition to event data, Event-Builder can transact status data such as the values of scalar, magnetic field of magnets, high-voltage supplying to detectors which are asynchronous with physics event.

Owing to parallel readout, the dead-time of new system is improved than previous system. If the number of modules per each CAMAC (VME) computer is small and conversion times of all modules are short enough, it is possible to achieve the dead-time of less than 100 μs per event. Since it is necessary to distribute common trigger to all CAMAC and VME modules,the dead-time of entire system is depends on the CAMAC (VME) computer having the longest dead-time.

For the event-build and analysis computers, Linux OS is used. On the other hand, RTLinux [6]

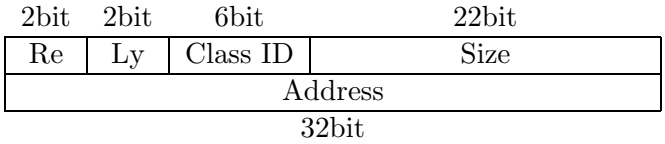

Figure 3: The header rule of RIDF. The size of this header is 64 bits.

which is the real time expansion of Linux is adopted for the front-end computers. Owing to RTLinux, high-speed data readout in stable is capable. As the data storage, RAID system labeled 'Storage' in Fig. 2 is installed in Storage Area Network (SAN). Event-builder and Analyzer computers can access RAID system at the same time via SAN.

The previous systems [3–5, 7] use RIKEN Data Format (RDF). For RIBF DAQ, a new raw-data format have been specified to satisfy 'hierarchic structure' and 'undefined block length'. It is named RIDF which stands for RIBF Data Format. According to this data format, all data are stored as blocks. In some cases, blocks include other blocks as their contents. There are some kinds of blocks:

- Global block: contains following blocks.
- Event block: contains segment block and scaler block.
- Segment block: contains acquired raw data.
- Scaler block: contains acquired scaler data.
- Status block: contains status data.
- Comment block: contains comments such as run information.

These blocks are indicated by the header words. Figure 3 shows the rule of the header word. The meaning of contents of header word is listed below.

- Reserve bit (Re): These bits are not used for the moment.
- Layer (Ly): Layer show hierarchical relation of each block. Usually the layers of global block, event block and segment block are 0, 1, and 2, respectively.
- Class ID: Class ID is the identifier of the block.
- Size: Size is the block size including header word in units of short word. The maximum size of one block is 8 MB, however it is encouraged to use less than 128 KB.
- Address: Address is the unique number of computer.

The detail of RIDF is described in Ref 11. The online/offline analysis program, ANAPAW [3,5], which has been widely used for the analysis of RDF, is extended to handle RIDF.

This RIBF DAQ system have been operating since February 2007.

References

[1] RIKEN Nishina Center : http://www.nishina.riken.jp/Eng/index.html

[2] T. Kubo : Nucl. Inst. and Meth. B**204**, 97 (2003).

[3] H. Baba et al.: RIKEN Accel. Prog. Rep. **34**, 221 (2001).

[4] H. Baba and S. Shimoura: CNS Annual Report 2001, 53 (2002).

[5] H. Baba et al.: RIKEN Accel. Prog. Rep. **37**, 187 (2004).

[6] M. Barabanov and V. Yodaiken, Linux Journal **34** (1997).

[7] T. Ichihara et al.: IEEE Trans. on Nucl. Sci. **36** 1628 (1989).

[8] H. Baba: *RIBF DAQ Manual*.