

UPGRADING THE CONTROL SYSTEM OF RIKEN RI BEAM FACTORY FOR NEW INJECTOR

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Abstract

To boost up the intensity of the uranium beam accelerated in the RIKEN RI Beam Factory (RIBF), a new 28 GHz superconducting ECR ion source was constructed in 2008. The standalone commissioning of the ion source has started in early 2009. In order to control the ion source as a part of the RIBF accelerator complex, we introduced F3RP61-2L as Input/Output Controller (IOC) and integrated them into the existing EPICS-based RIBF control system. F3RP61-2L is a new CPU module running Linux, which functions with the I/O modules of FA-M3 PLC on the PLC-bus. It is expected to make our control system simpler and easier to maintain. We will report the details of the control system of the new ion source and its integration into the whole RIBF control system.

OVERVIEW OF RIBF CONTROL SYSTEM

The RIBF has an accelerator complex consisting of one heavy-ion linac (RILAC) [1] and five heavy-ion cyclotrons including the world's first superconducting ring cyclotron (SRC) [2]. The injector system of the RIBF includes the RILAC, an AVF cyclotron and the RIKEN Ring Cyclotron (RRC) which have been used more than twenty years. Three newly-constructed cyclotrons (fRC, IRC, SRC) were commissioned in 2006 and started a beam service to users in early 2007. Most parts of the RIBF components are controlled using EPICS [3]. Many kinds of controllers are in use to control them, such as two kinds of our in-house controllers based on CAMAC and network interface, a control board based on VME and some kinds of PLCs. They are controlled and monitored by front-end controllers called IOC through Ethernet connections. In our system, almost all EPICS driver/device supports for controllers above mentioned are executed on Linux-based IOCs. To control the in-house controller based on CAMAC, we are using the network-based crate controller (CC/NET), which is a commercial product of Toyo Corporation [4] [5]. Since it is a single board computer based on Linux, we can execute EPICS base software on it. Therefore, the CC/NET itself is one of IOCs. On the other hand, both the network-based in-house controller (Network-DIM, N-DIM) [6] and PLCs don't have such kind of OS to execute EPICS base software on themselves. Therefore, in order to control them in EPICS, they should be connected with another EPICS IOC through Ethernet

connections to convert the communication protocols between EPICS Channel Access and PLCs or the N-DIM. For the RIBF control, a lot of Linux-based small single board computers are used as IOCs, and they execute software called netDev on them. The netDev was developed by ourselves in collaboration with the KEK control group in 2006 [7]. As an exception, only a type of control board based on VME is controlled and monitored by a device/driver support developed based on vxWorks. As a VME board, we are using NIO board which is a commercial product of Hitachi Zosen Corporation.

The in-house CAMAC based controllers control approximately 370 magnet power supplies, 100 beam diagnostic devices and vacuum systems. CAMAC system is applied to the components in the RRC, AVF cyclotron and their beam transport lines. On the other hand, the N-DIMs control approximately 250 beam diagnostic devices and vacuum systems. They are mainly applied to the devices in the three new ring cyclotrons, in their beam transport lines and around RILAC. Since the RILAC is the oldest accelerator in the RIBF, a step-by-step upgrade of the old control system is necessary for stable operation. PLCs control the vacuum systems for cyclotrons and some beam diagnostic devices. There are many PLCs in the RIBF, however, EPICS controls and monitors only about 12 of them. Other PLCs have their own control systems and they are independent from EPICS system. At last, NIO boards control approximately 420 power supplies for the magnets in the three new ring cyclotrons, in their beam transport lines and around RILAC. Table 1 shows the summary of interface controllers used in the RIBF control system.

ADVANTAGE OF SYSTEM WITH EMBEDDED EPICS

The RIBF control system has been operated without serious troubles for these three years and a lot of convenient functions have been introduced step by step. On the other hand, we have evaluated the use of F3RP61-2L as an IOC which controls various kinds of PLC modules. F3RP61-2L is a new PLC-CPU module running a soft real-time Linux produced by Yokogawa Electric Corporation and installation of EPICS on it has been developed by collaboration between the KEK control group and us.

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