Status report on update of alarm system and control system of magnet power supplies for RIBF

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We report the following two improvements of the RIBF control system. The first is the update of an alarm system, which supports the stability of beam delivery. The second is an improvement of the performance of the new module for the control system of magnet power supplies: NIO-C developed as a programmable logic controller (PLC) module.

In the RIBF facility, an alarm system has been operated along with the beam interlock system (BIS).[1)] We have applied an alarm system mainly to signals indicating abnormal conditions of hardware of the accelerator facility that may adversely affect accelerator tuning. We are monitoring the status of the following equipment with an alarm system now:

(1) Vacuum pumps and valves associated with the pump system, such as the on/off status of turbo molecular pumps on beamline.
(2) Vacuum pressure at the cyclotrons and beamline.
(3) Various devices in the AVF cyclotron and its ion sources, such as the on/off status of the radio frequency (RF) system and status of current from the magnet power supply for the main coil.

The numbers of signals from the equipment listed above are 198, 74, and 18, respectively.

The alarm system has been operated using a tool in the Control System Studio (CSS)[2)] and the Best Ever Alarm System Toolkit (BEAST).[3)] The BEAST is a distributed alarm system consisting of Alarm Server, a CSS user interface (UI) for viewing current alarms, and a relational database for configuration and logging. The BEAST was first introduced in the RIBF control system in 2012, and it has been actively used in recent times at the AVF console in the RIBF control room. As the AVF console was moved to a new location in the summer of 2019, we updated the platform that operates the Alarm Server and relational database from a dedicated PC to a server running CentOS 7 in a virtual machine to ensure its stable operation. The BEAST was also updated to the latest version. The latest version of the CSS software has undergone major improvements over the previous version in the connection method for experimental physics and industrial control system (EPICS)[4)] process variables (PVs). We newly employed CSS version 4.5.0 for the Alarm Server and PostgreSQL version 9.2.24 for the relational database, and CSS version 4.5.8 was newly installed on client PCs. In addition, with reference to the case of KEK, EPICS PVs dedicated to the alarm system are created separately from the EPICS PV used to control the equipment. They are operated on the EPICS input-output controller (IOC) dedicated to the alarm system. Changing the EPICS PV often requires a restart of the EPICS IOC, which may affect beam delivery. The new system allows changing alarm conditions during beam delivery without affecting the beam delivery.

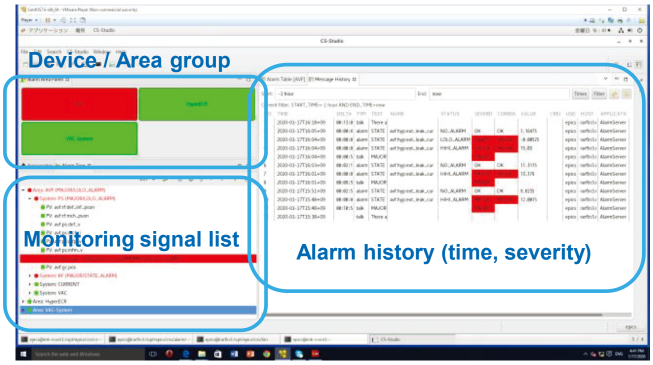

Fig. 1. Sample of the CSS UI for the BEAST operated at the RIBF control system. A green signal indicates normal operation, whereas red-highlighted signals are currently outputting an alarm (except for the alarm history part).

The second is related to the NIO-C successor developed as a PLC module in 2016.[5)] We reported in Ref. 5) that we could successfully control 34 magnet power supplies by using the NIO-C successor in the same manner as the existing system, which uses the NIO-C developed based on the Versa Module Eurocard (VME) bus. However, it became clear that the command processing time of the NIO-C successor is longer with higher fluctuation than that of VME-based NIO-C. While the command processing time for one NIO-S was 11.8 ms on average and fluctuated in the range of 11.7–11.9 ms in the VME-based NIO-C system, the NIO-C successor system took 18.3 ms on average and fluctuated in the range of 4–37 ms. The speed is too slow in actual accelerator operation. After investigation, we found that the slow speed is caused by a logic of polling performed by NIO-C, which is one of the important functions of the NIO system. By improving the logic, the average command processing time was shortened to 7 ms on average, and the fluctuation range was narrowed down to 2.7–12.2 ms. The next step is to determine whether the new system shows the same performance in an actual operating environment, in which several NIO-Ss are connected to one NIO-C.

References

1) M. Komiyama *et al.*, RIKEN Accel. Prog. Rep. **39**, 239 (2006).
2) `http://controlsystemstudio.org/`.
3) `https://github.com/ControlSystemStudio/cs-studio/wiki/BEAST`.
4) `https://epics.anl.gov/`.
5) M. Komiyama *et al.*, Proc. PCaPAC2018, pp. 66–68.

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