IMPROVEMENTS FOR SIMPLE OPERATION AT SAGA-LS ACCELERATOR

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Abstract

The SAGA Light Source is a medium-size synchrotron light research facility located at Kyusyu Island, Japan. The control system of the SAGA Light Source has been developed in the early phase of the machine commissioning. The application programs were developed using PC-LabVIEW. Commercial off-the-shelf input/output devices, such as PLC with a MS-Windows PC server, compose the input output controller with a high cost-performance ratio. ActiveX CA is used for the communication protocol between the server PCs and the client PCs. All of the components of the accelerator except the timing system are now controlled using PCs. Although the control system is stable, having many client PCs complicated the daily operation. Thus, we developed a multi-purpose client program, which is running on MS-Window 7 with a touch panel display. Furthermore, we constructed communication interface between the accelerator control system and the radiation interlock system to set the interlock mode from the accelerator control system. By using the developed multi-purpose client program and the interface to the radiation interlock system, the numbers of procedures necessary for daily accelerator operation have been significantly reduced, making the daily operation simple.

SAGA-LS CONTROL SYSTEM

The SAGA Light Source (SAGA-LS) is a medium-size synchrotron light research facility located at Kyusyu Island, Japan, and the accelerator consists of a 255 MeV injector linac and 1.4 GeV electron storage ring [1], [2]. At this time, all of the accelerator components are controlled by a digital system except for the timing system. For connectivity to the accelerator hardware, we selected commercial off-the-shelf distributed input/output (I/O) devices, such as a programmable logic controller (PLC) (Yokogawa: FA-M3) and distributed I/O controller devices (National Instruments: Fieldpoint). A difficulty at the SAGA-LS facility is its tightly restricted budget, which limits the number of staff in the facility. Thus, the control system for SAGA-LS should be simple and robust, yet inexpensive, easy to develop, and easy to maintain. One of the solutions to this problem is the use of off-the-shelf products, including PCs. The off-the-shelf I/O device and server PC works as the PC Input Output Controller (PC-IOC). Figure 1 shows a schematic view of the control layer of the SAGA-LS control system. For clarity, many of the accelerator components are omitted. We developed applications in the PC-LabVIEW environment because accelerator staffs are familiar with the PC-LabVIEW.

The PC-based control system is widely used in many facilities because of the high cost-performance ratio of using PCs. Especially recent improvements in the performance and the cost effectiveness of PCs have made them attractive for use in the accelerator control system. There are sophisticated and well-established control systems based on workstations or PC-UNIX, such as the Experimental Physics and Industrial Control System (EPICS). However, it is difficult to modify and expand the EPICS system with limited accelerator staff. Fortunately, the number of control items of the SAGA-LS is now approximately 600 and there are very few demands for real-time control. The only exception is the synchronous operation of power supplies for the four minutes of the energy ramping in the storage ring. In this case, a PLC with a preloaded ramping pattern is suitable. Hence, we designed a MS-Windows PC-based control system with off-the-shelf I/O devices [3], [4]. For the communication protocol between the server PCs and the client PCs, we used ActiveX channel access (CA) [5], which emulates the EPICS CA protocol. MySQL was adopted as the database system. Recent progress on the control system for both the linac and the insertion devices are summarized in reference [6]. The feedback control system for the magnet power supplies using external DC current transformer, feed-forward orbit, tune and coupling correction systems have been developed in past years.

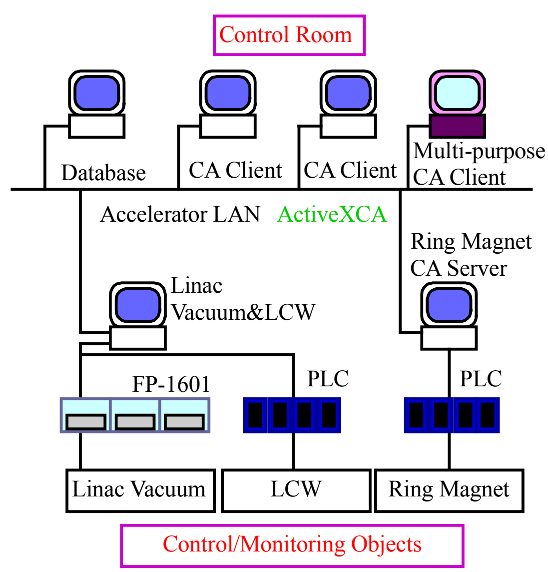

Figure 1: Schematic view of the control layer of the SAGA-LS.

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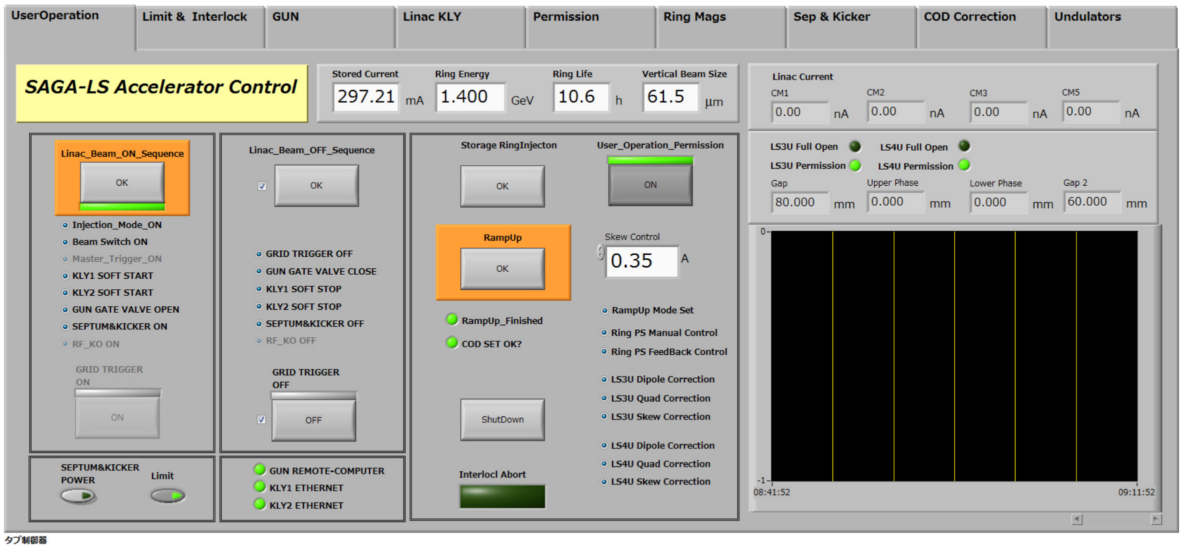

Figure 2: Front panel of the multi-purpose application program on MS-Windows 7 with touch panel. Each client function is displayed by selecting the relevant tab keys.

MULTI-PURPOSE CLIENT APPLICATION

Design Concept

As the accelerator improving, the numbers of client PCs have been growing, since each client application is created in each PC independently. Although good stability and a rigid framework of the accelerator components do not require complicated manipulation of the machine parameters in daily operation, increasing the number of client PCs increases the complexity to the operation. The necessity of setting many control knobs sometimes causes human errors. In our facility, during the injection operation, we have to carry out more than 20 processes. Although a small number of machine staff is enough for stable and safe operation in the SAGA-LS accelerator, only one accelerator staff and one assistant are actually assigned as machine operators. Thus, to avoid human errors and to simplify the machine operation, we recently constructed a multi-purpose client application program. Figure 2 shows the front panel of the application. Several operation procedures are automatically processed by the multi-purpose client application. The design concepts of the application program are as follows:

- Development in the LabVIEW environment.
- Inclusion of the major functions of each CA client program in one application program.
- Switching to these client functions by selecting the relevant tab keys.
- The application procedures are sequentially processed in the operation scheme.
- Use of MS-Windows 7 and the touch panel display.

Implementation

We have started the machine commissioning of SAGA-LS in 2004, and we used MS-Windows 2000 on the control PCs. The client programs were constructed as single-task programs for robust operation.

The construction of the multi-purpose application was made possible by recent improvements in PC CPU power and memory size. The multi-purpose client program runs on an Intel (R) Core (TM) i3 3.07 GHz CPU with 2.0 Gbyte memory and treats more than 110 EPICS CA process variables. The CPU usage is less than 10%. The application includes the electron gun, linac klystron modulator, ring power supply, global closed orbit distortion (COD) correction program, two undulators, and injection magnets (septum and kicker magnets). These client functions are switched between using tab keys, as illustrated in Figure 2. The original CA clients were constructed as “multi-stand-clients”; in other words, simultaneous and multiple runs on different PCs are possible. Such a performance is realized by using “set value” and “read back value” in ActiveX CA with LabVIEW programming [5]. Due to the “multi-clients” structure of the program, translations of the CA client programs to the multi-purpose application have become straightforward. Both the multi-purpose client program and the original client programs can be used simultaneously. In the multi-purpose application program, the “Event Structure” and “Stuck Sequence Structure” are mainly used for the automation operation processes.

The touch panel display is supported formally by Windows 7. Actually, the touch panel and the touch panel PC capability existed before Windows 7. But, with Windows 7, the high-resolution touch panel display can be used without any device driver and at low cost. We use iiyama ProLiteT2250MTS (1920x1080) for the multi-purpose client touch panel display. The resolution of the touch panel display of the system is sufficient for creating such accelerator application program. Though the touch panel display is not necessary device, it significantly increases the intuitive manipulation of the machine control.

The ring RF system, the RF-knockout (RF-KO) system for the bunch filling pattern, and the master trigger are not yet contained in this application. The master trigger system will on-line in 2011, and the RF-KO system will be added to this application in the near future. The ring RF control system will be contained with slight modification of the original ring RF CA client program.

INTERFACE TO THE RADIATION INTERLOCK SYSTEM

The radiation interlock system was originally constructed independently of the accelerator control system for rigid operation. The radiation interlock system only produces permission signals for operation of the accelerator control system at injection and ramping up. Due to the independency of these systems, the operation has become stable and the maintenance is easily performed. But, for easy accelerator operation, it is better to have an interface between the accelerator control systems and the radiation interlock system. Hence, the next five signal interface to the accelerator control system and radiation interlock system were constructed:

- Injection Mode Set/Off.
- Beam Switch On/Off.
- Acceleration of the storage ring and Accumulation Mode Set/Off.
- Acceleration Permission for the storage ring.
- Experimental Operation Permission.
- Monitoring of each status.

For constructing interface, a new PLC is installed in the accelerator LAN. By sending a signal from the multi-purpose client application to the accelerator PLC, the PLC produces the prescribed pulse to the PLC of the radiation interlock system. The status signals from the interlock system are also captured using the accelerator PLC. Figure 3 shows the communication interface between the accelerator control system and the radiation interlock system. For secure communication, the signals are hardwired and not directly connected with the Ethernet LAN.

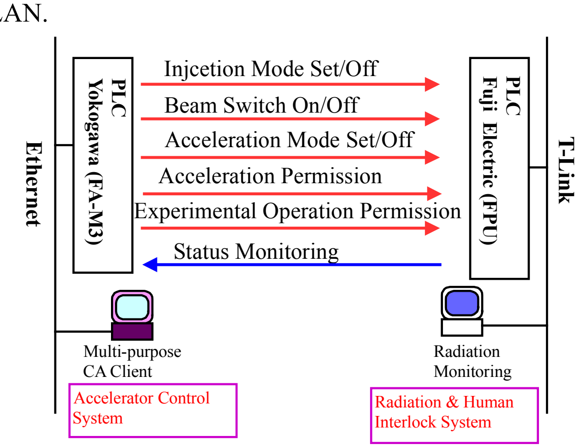

Figure 3: Interface between the accelerator control system and the radiation interlock system.

TOTAL PERFORMANCE

Before installing the multi-client application program, we had to carry out more than 20 steps from the injection to the user's experimental operation. Using the new multi-purpose application program, following eight steps for injection operation are eliminated:

I. Set Injection Mode.
II. Beam Switch ON.
III. Set Linac Klystron Shutdown.
IV. Set Ramp up Permission.
V. Set Acceleration and Accumulation Mode.
VI. Set Ring PS Tuning and Feedback ON.
VII. Set Global COD correction.
VIII. Set Insertion Devices to their home position.

In the injection processes, we only use three PCs (multi-purpose application, RF-KO, and ring RF system) and a switch (master trigger). The manipulation of the radiation interlock system is completely automated in the injection processes. Furthermore, the shutdown process was partially automated by setting the insertion device to the full open position and by setting the interlock mode of the acceleration and the accumulation to off.

By including the master trigger and the RF-KO systems on the multi-purpose application, a total of 10 steps will be reduced. We are intending to achieve "one-touch" accelerator operation by the multi-purpose client application near future.

SUMMARY

We constructed a multi-purpose client program and interfaces between the accelerator and radiation interlock system. In the multi-purpose client program, many tasks for injection are sequentially processed step by step. By developing this multi-purpose client application, the complexity of daily operation has been significantly reduced. In addition, adopting a touch panel display with MS-Windows 7 allows intuitive accelerator operation.

REFERENCES

[1] T. Tomimasu, et al., "The SAGA Synchrotron Light Source in 2003", PAC'03, Portland, May 2003, p. 902 (2003).
[2] Y. Iwasaki, et al., "Lattice Design of SAGA Synchrotron Light Source", PAC'03, Portland, May 2003, p. 3270 (2003).
[3] H. Ohgaki, et al., "Design of Control System for SAGA Synchrotron Light Source", PAC'03, Portland, May 2003, p. 2387 (2003).
[4] H. Ohgaki, et al., "PC-LabView Based Control System in SAGA-LS", PAC'05, Knoxville, May 2005, p. 3976 (2005).
[5] K.-U. Kasemir, (2003); http://icsweb.sns.ornl.gov/kasemir/axca/index.html.
[6] T. Kaneyasu, et al., "Present Status of the SAGA-LS Control System", ICALEPCS'09, Kobe, October 2009, p. 307 (2009).