

1. Accelerator

1. Accelerator status and activities

Although there were several troubles, the user time of SPring-8 and SACLA was completed as scheduled in FY2024. Major troubles of SPring-8 were associated with an RF water cooling system and magnet power supplies due to equipment aging. Regarding SACLA, the electron gun tank replacement was initially scheduled in a summer shutdown period, but the frequency of gun trips caused by high-voltage discharge increased and the gun tank was decided to be replaced during a machine tuning day in July. The replacement work began at 10:30, and the beam operation was resumed at 16:30 on the same day. There were also several minor troubles. The corrosion of some high-voltage ion pump connectors was observed at the SACLA undulators. The power supplies of a switchyard kicker magnet and XSBT bending magnets triggered alarms several times, which stopped output. The failure rate of the magnet power supplies, such as steering, quadrupole and sextupole magnets, has also been increasing at the SPring-8 storage ring in recent years. In spite of these troubles, however, the accelerator operation was sustained, owing to the system redundancy, without substantial operation interruption.

In terms of performance improvement, the IOT amplifier of 476 MHz was upgraded to a solid-state amplifier at SACLA BL1. To prepare for the upcoming SPring-8-II, a half-cell was assembled to check spatial interference among components. Several studies were also carried out at the SPring-8 storage ring. Since current 508 MHz RF cavities will continue to be used in SPring-8-II, higher order

mode (HOM) characteristics were measured and investigated. The beam-based alignment system of beam position monitors (BPMs) was developed and tested using the current accelerator. The positions of photon beamlines were measured with respect to the electron beam trajectory of the current storage ring, and the obtained data will be used for the future installation and alignment of SPring-8-II. Various studies and developments are underway toward SPring-8-II.

2. Control system

2.1 Status

In FY2024, we continued to improve the control system of SPring-8 and SACLA, and some improvements were aimed at SPring-8-II. Several components of the control system were replaced.

- The file server of SPring-8 and SACLA was upgraded to a fault-tolerant server in March. This was intended to address the end of support and maintenance, and it also improved performance.
- The network system of SACLA was replaced. This was intended to address the end of support and maintenance. All network switch ports were working with Gigabit Ethernet to connect servers using 10G Ethernet. The 10G Ethernet port could not connect to 100M Ethernet of old network switches.
- The operating system (OS) of the operation consoles of SPring-8 was replaced to Ubuntu 22.04LTS ^[1]. To maintain compatibility with existing GUIs, we transferred old MADOCA-based GUIs to a new OS environment. A

migration of the GUI builder from the old-fashioned X-Mate to Qt was also planned. Qt will be used for all GUIs at SPring-8-II. We finished replacing the OS by the end of 2024 for SPring-8, and we plan to replace the OS for SACLA and SACLA BL1 in FY2025.

- The network system of entrance and exit control to radiation areas was replaced and separated from the accelerator control network. During the SPring-8-II construction period, the entrance and exit control to radiation areas must remain operational, while the accelerator control network is being reconstructed. By separating the network, the SPring-8-II construction can proceed more smoothly.
- The control system of IDs was replaced due to the installation of new insertion devices, IVU-II, at SPring-8, which will continue to be used at SPring-8-II. The system is based on the EtherCAT protocol with a PC server-based EtherCAT master for pulse motor control, the vacuum system, and the RF BPM system. Figure 1 shows a schematic view of the control system.

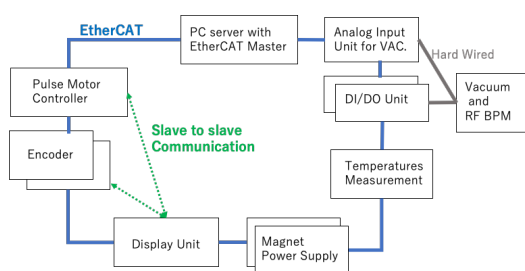


Fig. 1. Schematic view of the control system for an insertion device. The EtherCAT master is used with a PC server.

2.2 Development of the device driver for CC-Link IE Control

The vacuum system of SPring-8-II will use a programmable logic controller (PLC) with CC-Link IE Control as the network between PLCs. We will use a PC server for equipment control with a PCI Express board of CC-Link IE Control. For this, we developed a device driver for Ubuntu 22.04LTS that allows a PCI Express board of CC-Link IE Control to communicate with the vacuum system (Fig. 2).



Fig. 2. Photograph of PCI Express board of CC-Link IE Control.

2.3 Development of an MTCA.4 board for the device interlock system

We plan to use MTCA.4 for the BPM system. One of the BPM system functions is to detect orbit distortions. When orbit distortions occur, synchrotron radiation may hit the vacuum chamber walls and damage equipment. We developed an interface board that connects the BPM system to the device interlock system. The functions of this board are as follows.

- Receive interlock signals via M-LVDS of MTCA.4 backplane or software event
- M-LVDS line selection
- Send interlock signals using RS485
- Record interlock signals during MTCA.4 register storage of data in a database

We developed a device driver for this board on Ubuntu 22.04LST. Figure 3 shows an interface board with an MTCA.4 form factor.



Fig. 3. Photograph of the interface board with MTCA.4 form factor. LEDs display interlock status. DIP SWs (red) select M-LVDS lines. The RJ45 port is used for the RS485 signal.

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References:

[1] Okada, K. et al., to be presented in WAO 2025.