Safety interlock system for LINAC building

A. Akasiho,[*1] H. Sakamoto,[*1] and K. Tanaka[*1]

An interlock system of the LINAC building toward human safety (LHIS) works for human radiation safety and compliance with radiation lows. Because the previous interlock system was operated for 30 years, it was too complicated to operate and maintain through long-term repeated system improvements and generational changes of developers. Further, a machine protection system (MPS), that is applied to accelerator machine safety, was part of the previous interlock system. This was an operational risk wherein both machine protection and human safety systems were in the same system as it was possible to cause operational conflict. Therefore, the new LHIS was completely separated from MPS.

Figure 1 shows the chart for a new LHIS. In this system, a programmable logic controller (PLC) controls each safety device in the LINAC building directory. The indicator light shows "beam on" or "beam off" at the entrance doors of the irradiation room and the accelerator room, as shown in Fig. 2. The status of the doors are monitored, and then the LHIS determines whether beam irradiation is possible. When the radiation workers enter the irradiation rooms, all take safety keys to recognize the LHIS where the workers are in the room and to inhibit beam irradiation. A radiation monitor generates a signal to the LHIS if it detects an abnormal dose level. Radiation dose level are recorded to radiation monitoring system. An access control PC independent from LHIS and operated by an access management system generate a signal to the LHIS if a worker handles its entry operation during beam irradiation.

Figure 2 shows an operational screen for the LHIS operational PC (LHIS PC) that sends operational commands to PLC as shown in Fig. 1. The schematic diagram of the LINAC building is displayed. The LHIS covers three areas which are accelerator room, irradiation room of the Linac building, and the Connecting building. Each area has its own beam shutter (BS) to stop the beam discretely if an interlock incident occur. Each BS on the accelerator is set on its upstream part to stop a beam before entering the room, as shown in Fig. 2. In the previous systems, a faraday cup, which is applied for accelerator operation, is also commonly applied as BS. The BSs are independent of the faraday cups at LHIS.

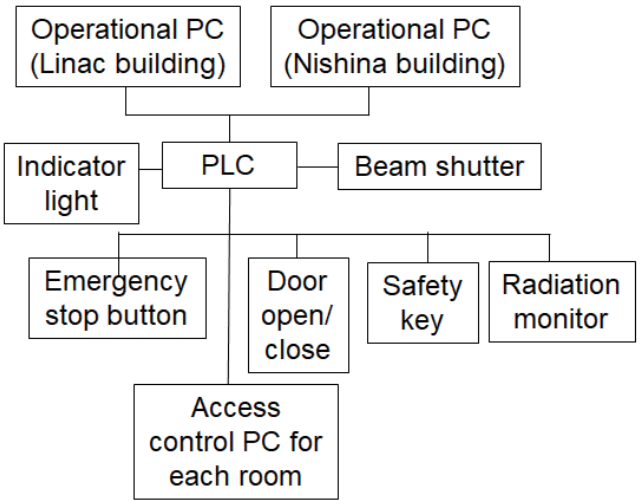

Fig. 1. Conceptual diagram for new LHIS.

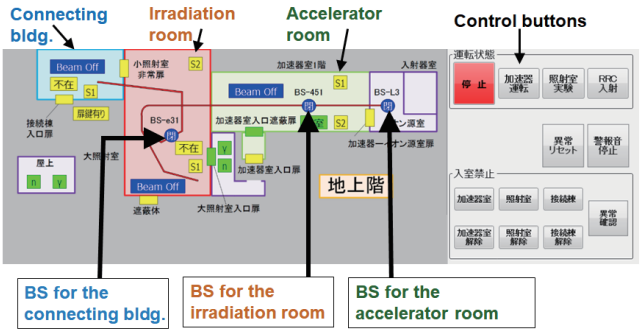

Fig. 2. Part of screen of LHIS PC. Positions of BSs are indicated.

Instructions are issued from the LHIS PC to PLC remotely. The LHIS PCs are set at a radiation control room in the Nishina building and an accelerator operation room in the LINAC building. The position of each operated device such as doors for the accelerator room and the irradiation room is shown in Fig. 2. Green color for the devices shows an acceptable status of a beam irradiation, corresponds to "close" for the door case. A yellow color door shows abnormal status of door "open." All operations for the devices are recorded in the LHIS PCs.

LHIS is handled by the accelerator operators for RILAC. The operators choose a button on the screen for the beam irradiation area. Then LHIS analyzes conditions of the safety devices for accelerator operation and beam irradiation. A BS opens if all statuses are good. If any status is not sufficient, an "abnormal" indication is displayed and the BS does not open. While the BS open, if a door for accelerator or irradiation rooms open, the LHIS status changes to "abnormal" and BS closes.

The LHIS operation was successfully started at October 2019. At 2020, a rotating red light was installed at the entrance of the irradiation room to show the X-ray risk by the RILAC RF cavity.

*1 RIKEN Nishina Center