INTERLOCK AND BEAM EXPOSURE CONTROL SYSTEM FOR HIGH CURRENTS TANDEM ACCELERATOR*

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Abstract

We have developed the interlock and beam exposure control system of NIRS Neutron exposure Accelerator System for Biological Effects Experiments (NASBEE) The TANDETRON 2MV HC+5812, by HVEE, is adopted as the main body of system. The facility comprises both accelerator - based neutron and RI - based gamma exposure systems, where radiation control area and biological SPF control area are intermingled. The system has to control any access in view of both aspects of interlock. The major interlock in neutron exposure area is realized first by a FC that stops the beam before the accelerator tube, and then terminal voltage control. Radiation from neutron target must be shielded also before accessing to the area. The development system comprises three PLC's and PC. Three PLC's control interlock, exposure devices, and area-access, respectively, system makes exposure control and measurements easy. Further improvement for user-friendliness is expected in future.

FACILITY

NIRS construct a low dose effects research facility for biological science in 2004, and installed NASBEE system. The high current 2MV tandem type accelerator manufactured by HVEE is the main system of this. It can accelerate proton and deuteron to 4MeV, and maximum beam current is 800 microampere at proton. By applying beams to Beryllium metal or Lithium compound targets, fast neutron whose mean energy is 2MeV is generated. Figure 1 shows a schematic diagram of this system. [1][2]

In the facility, there are two-irradiation rooms for neutron exposure. One is used for physical experiments and irradiates the biological sample carried in this facility. The other is for the specific pathogen free (SPF) animal irradiation. This SPF irradiation room is placed in the animal control area called as SPF area. After installing the experimental instruments, the SPF area is cleaned by formalin and ethanol. When enter in the area, we are required to put on clean room wares. In the SPF area, two sets of gamma exposure system are also installed.

SYSTEMS

Main Interlock System

PC, Main PLC, card reader system, and door lock system construct the main interlock system. Figure 2 shows the schematic of the main interlock system and relation with irradiation system. This system also controls a door lock system for the entrance of the facility and the SPF area. In Figure 3, the position of interlock related doors, SPF area, and radiation control area are shown.

The characteristics of the main interlock system are that it controls both of the animal control area and the radiation control area, and has traffic pattern in PC. When you want to enter the SPF animal irradiation room, you must pass the entrance doors of the facility, SPF area, and anteroom by using ID card.

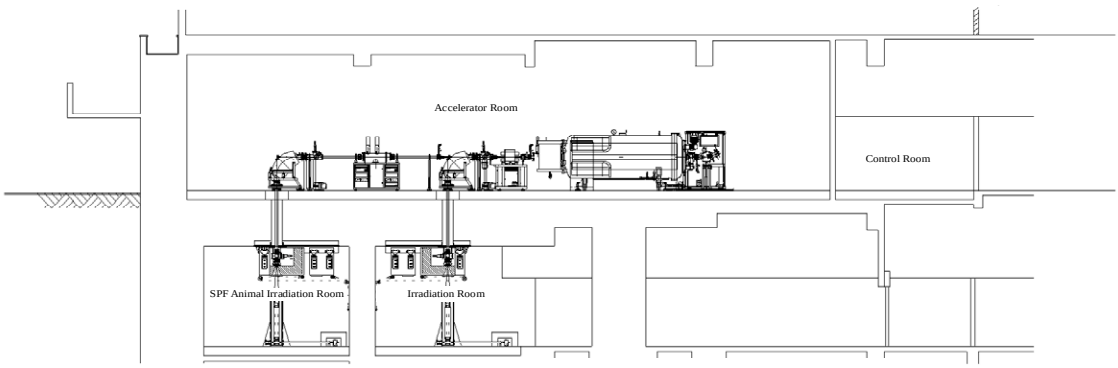

Figure 1: Layout of NASBEE system.

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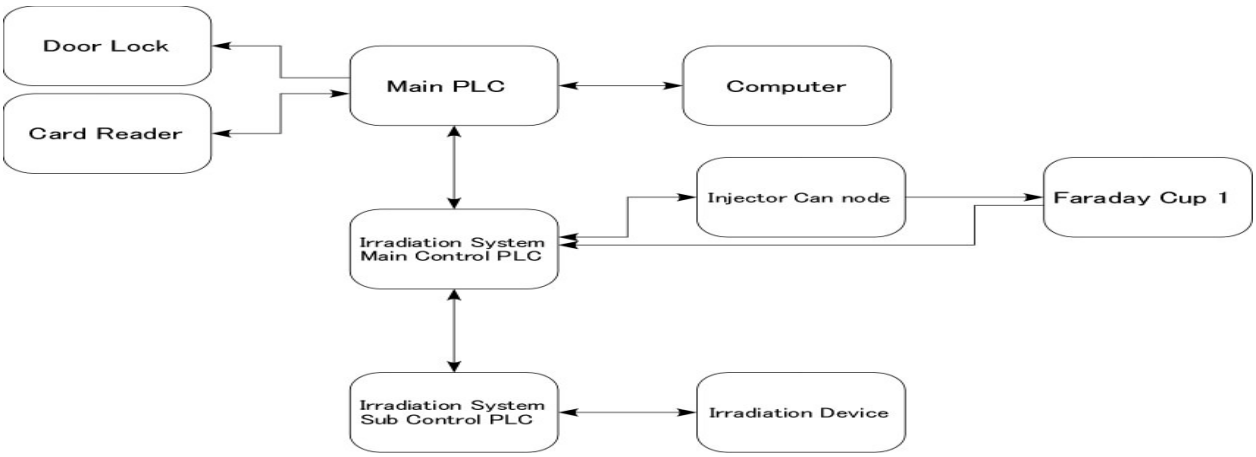

Figure 2: Schematic diagram of Main Interlock System.

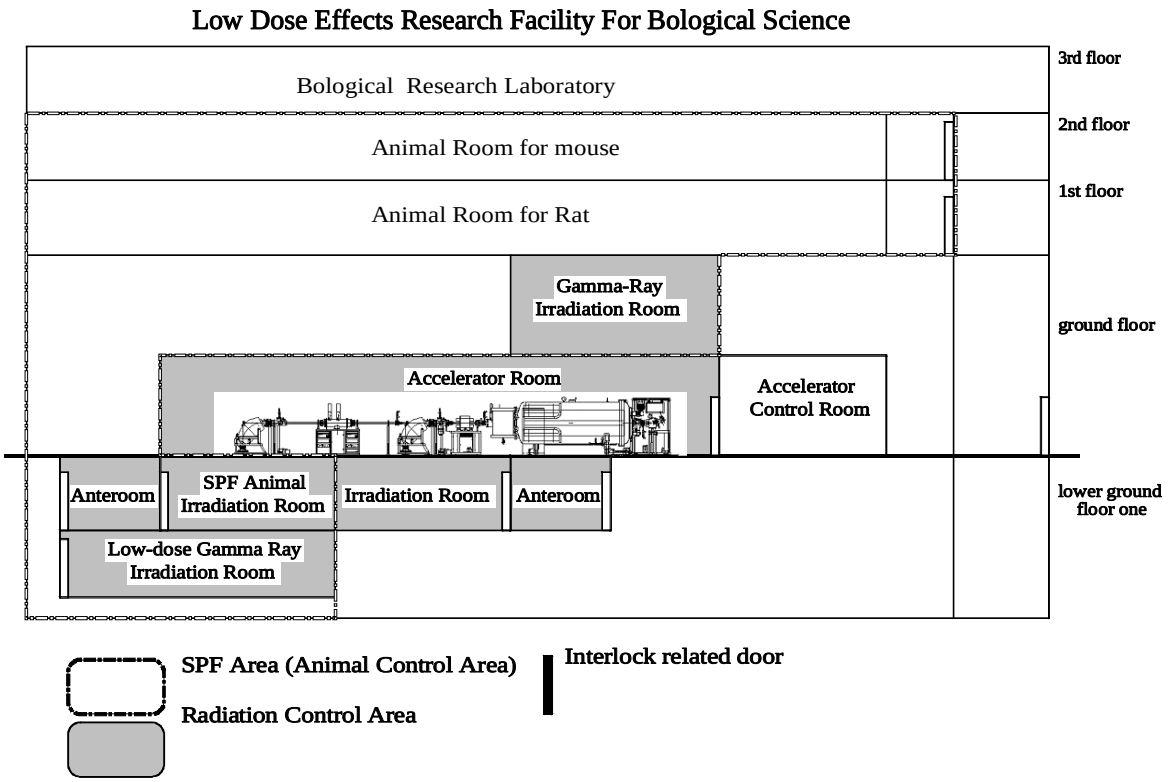

Figure 3: Schematic of low dose effects research facility for biological science.

The HVEE HC-current type accelerator system provides four customer interlocks of FC1 (faraday cup set between ion source and accelerator tank) close, High Voltage shut down, power supply for ion source shut down, and radiation level high. In these, the main interlock system uses “FC1 Close”, and “High Voltage shut down”. “High Voltage shut down” is used for high-level emergency signal of door unlock. When low-level emergency happen, FC1 is the convenient for us to use as an interlock related beam shutter. Because it is set between the ion source and the accelerator tank, we can shut high-current beam in the extremely low power state. So, the “FC1 close” is use for unlocking the doors of radiation control area for all emergencies.

Figure 4 shows the required condition to unlock the interlock related doors of radiation area. In addition to “FC1 close”, “Area Monitor Normal”, “Target shield close”, and “Target shutter close” are needed to open the

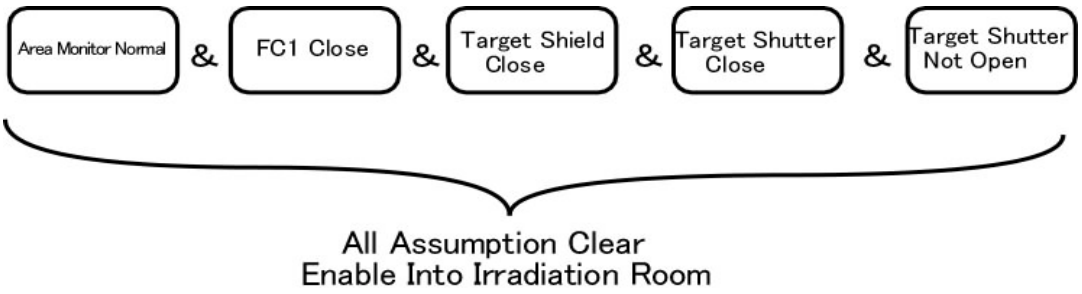

Figure 4: Required condition to unlock door of radiation control area.

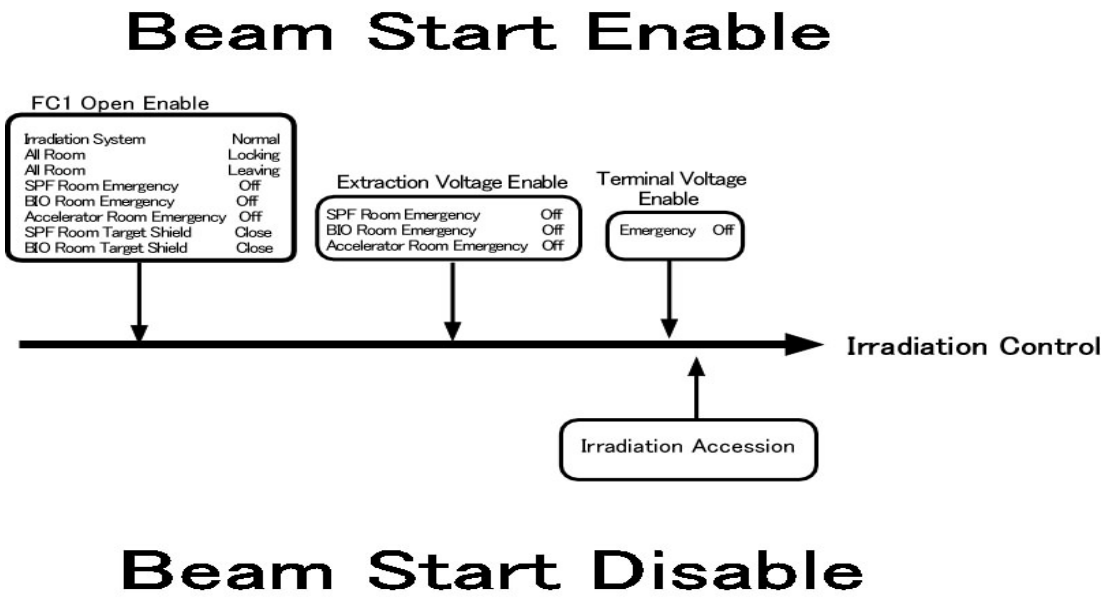

Figure 5: Required condition to open FC1.

interlock related doors without gamma-ray irradiation rooms.

Of course, we also use the FC1 for beam conditioning or fixing. Figure 5 shows the required condition to open the FC1.

As mentioned above the main interlock system is closely related to irradiation control system of the NASBEE.

Irradiation Control System

An irradiation control PC, main and sub PLC's construct the irradiation control system. PLC's are controlled by the PC, and they send or receive signals of the NASBEE devices as can node included accelerator system, two sets of wobbler magnets, thermometers for targets, current integrator, and X-Y automatic stage. All of these devices are finally controlled by the PC. Figure 6 shows the schematic diagram of the irradiation control system.

The wobbler magnet use to from expansion neutron irradiation field and to disperse the heat of the metal target caused by high-current beam irradiation.

The X-Y stage uses for dose distribution measurement. When beam exposure is ready to start, the ready status is made in main PLC and it sends ready signal to irradiation control PC. Then pushing a virtual "beam-on" button on PC, the beam is exposed till reach the integrated beam current to preset value. After finishing the beam exposure, the stage moves to next measurement point.

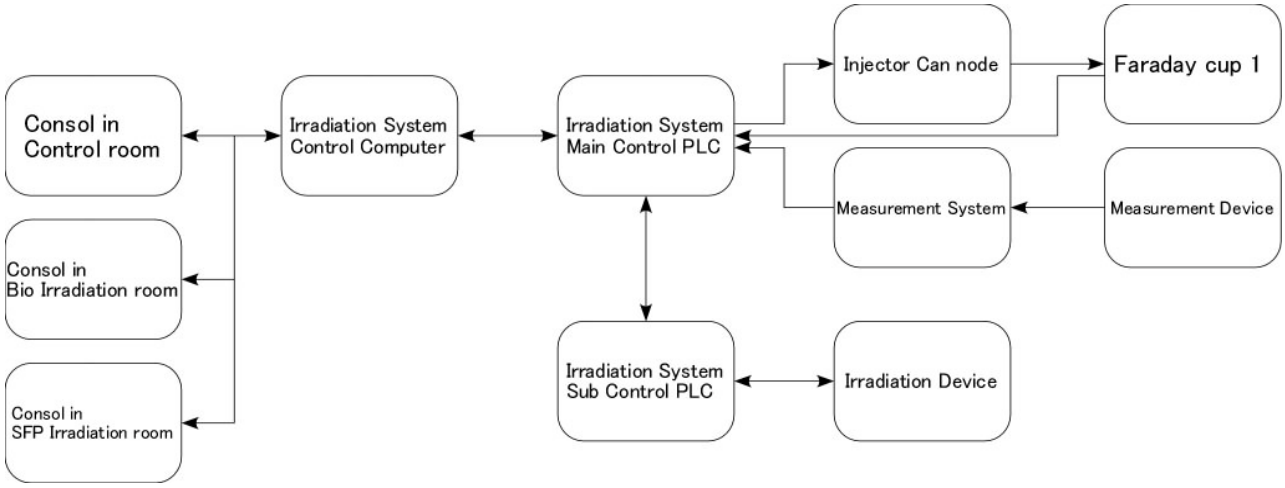

Figure 6: Irradiation System Layout.

SUMMART

Though we finished installation of NASBEE system, we have been constructing the neutron exposure system for safety use and improvement for user-friendliness is expected in future.

REFERENCES

[1] S. Whittlestone, “Neutron distributions from the deuteron bombardment of a thick beryllium target”, 1977 J. Phys. D: Appl. Phys. 10 1715-1723

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