ISBN: 978-3-95450-214-1 ISSN: 2673-5490 doi:10.18429/JACoW-IPAC2021-TUPAB318

THE BEAMLINE SAFETY INTERLOCK SYSTEM OF TAIWAN PHOTON SOURCE

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Abstract

The energy of synchrotron radiation generated by bremsstrahlung radiation and magnet is rather high, which may cause serious radiation damage to human body or even imperil people's life. The beamline therefore must be equipped with radiation-protection system; in addition, the overheat of optical components exposed to synchrotron radiation will lead to the damage of optical components and devices. In consequence, the beamline should be furnished with the cooling-protection system to cool down optical components and devices. The Beamline Safety Interlock System targets at protecting the personnel and the safety of devices, limiting the radiation dose to a security value for experimental personnel or staffs exposing to radiation on the site as well as preventing beamline components from being exposed to overheat or vacuum damages to improve the effectiveness of beamline.

FOREWORD

This article will explain the safety interlock system that protects the personnel, vacuum environment and equipment, and makes the lab or work staff safely use the beam facilities in order to prevent the components being subjected to overheating or vacuum damage. There are three designs, including radiation protection, vacuum protection system and cooling protection system. The above protection systems will correctly operate under the control of the safe chain software of the correct protection logic to achieve the safest protection effect for the personnel.

SYSTEM ARCHITECTURE

The chain system includes a radiation safety chain system, a vacuum safety interlock system, and a cooling safety interlock system. In the following, the safety interlock system will be separately described [1-2]. (See Fig. 1).

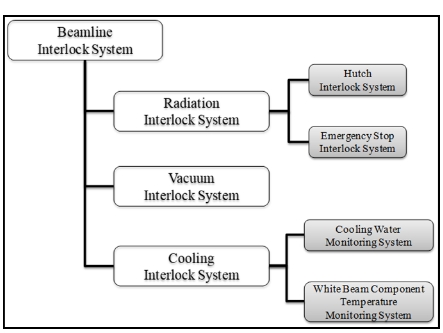

Figure 1: System architecture of Beamline Interlock System.

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RADIATION SAFETY INTERLOCK SYSTEM

When the beam is turned off, the radiation dose rate will be a background value; when the beam is turned on, the radiation dose rate will rise sharply to be within a dangerous range. Therefore, a radiation shielding house needs to be designed to block the radiation, and a standard operating procedure shall be incorporated into the logic loop monitoring of the radiation safety chain system to avoid the possibility of the condition of the personnel being exposed to a radiation workplace. (See Figs. 2 and 3).

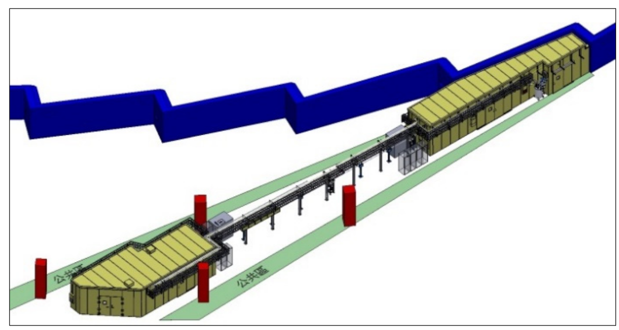

Figure 2: The picture of TPS Optics Hutch.

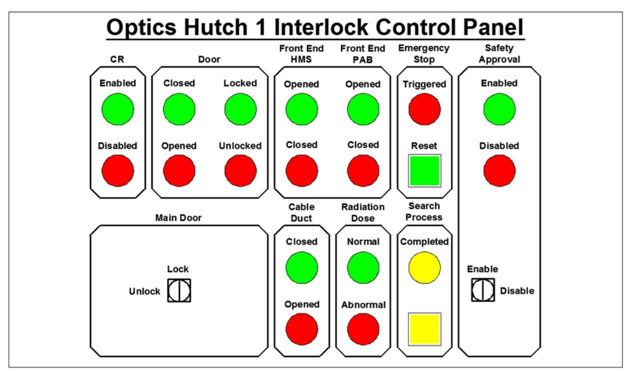

Figure 3: The picture of Optics Hutch Interlock Control Panel.

In addition, an emergency stop button is directly connected to the equipment in the house to protect personnel from radiation damage during the operation. Therefore, when the person in the house is in the light emitting state, the emergency stop button should be immediately pressed to stop the radiation from accumulating damage. (See Fig. 4).

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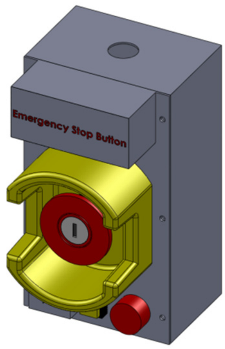

Figure 4: The picture of emergency stop button.

ACTIVE DUMP BEAM PROTECTION MECHANISM

To ensure that the personnel does not suffer from high-dose radiation damage when they stay in the radiation control zone, in addition to the passive dump beam protection mechanism provided by the person pressing the emergency stop button, the dump beam active protection mechanism is also provided via the safety chain system. The method thereof is the security chain system using the physical signal of the off state of the front-end zone HMS, and then it is combined with all the access limit switch signals and the P.S. switch signal to achieve a personal security protection design with level higher than that of the immediate active personnel security protection. (See Fig. 5).

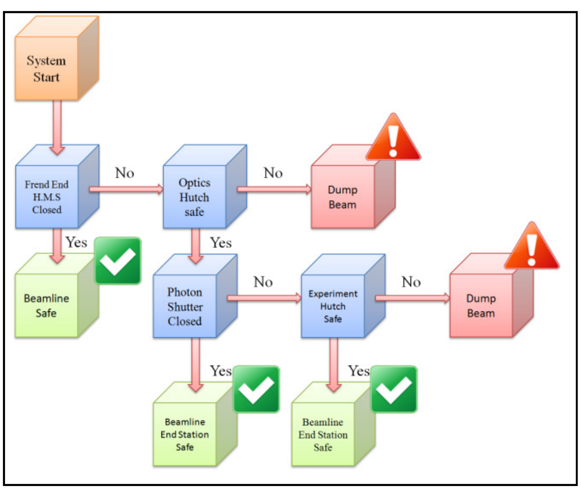

Figure 5: The picture of active dump beam protection mechanism.

PHOTON SHUTTER AND ACTIVE DUMP BEAM

Photon shutter is one of the most important safety components. Because the state of the photon shutter is necessarily obtained in the active dump beam procedure, a photon shuttering mechanism able to give signals to the chain system and the active dump beam procedure simultaneously without making the signals interfering with each other is designed. This design applies a limit switch for inputting signal to avoid signals being not synchronous. (See Fig. 6).

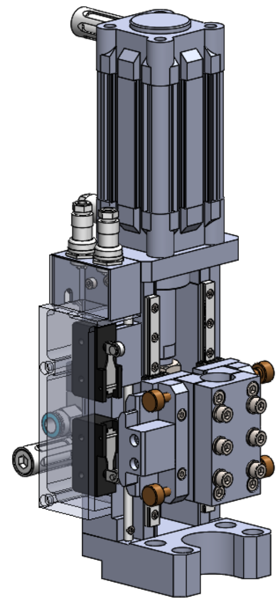

Figure 6: The picture of Photon shutter.

VACUUM SAFETY INTERLOCK SYSTEM

Ultra-high vacuum is one of the necessary conditions for operation. When the vacuum system is used, the vacuum system is communicating via Front end with Storage ring. Thus vacuum abnormality may occur in Beamline and result in failure to operate. According to the state detected by the vacuum gauge, the safety logic control is performed. When the controlled component does not meet the set conditions, the system will perform the corresponding protection action according to the preset logic design. (See Fig. 7).

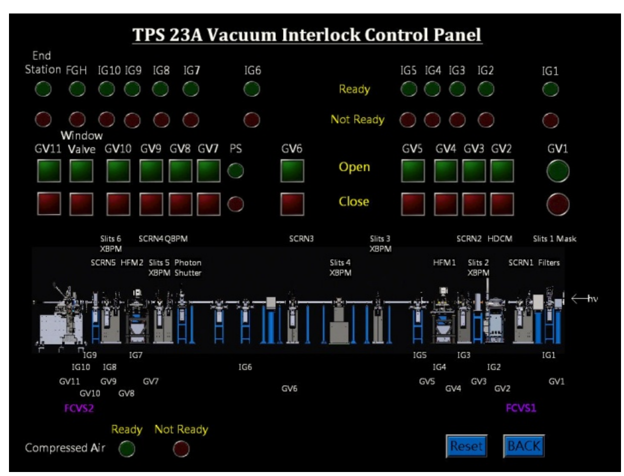

Figure 7: The picture of Vacuum Interlock Control Panel.

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BEAMLINE COOLING SAFETY INTERLOCK SYSTEM

The high-energy and high-brightness light source in Beamline also brings a high heat load to the component. Since the thermal load of the white light section is enough to damage the operation function of the component, it is very important to set the safety chain system to perform cooling protection. (See Fig. 8).

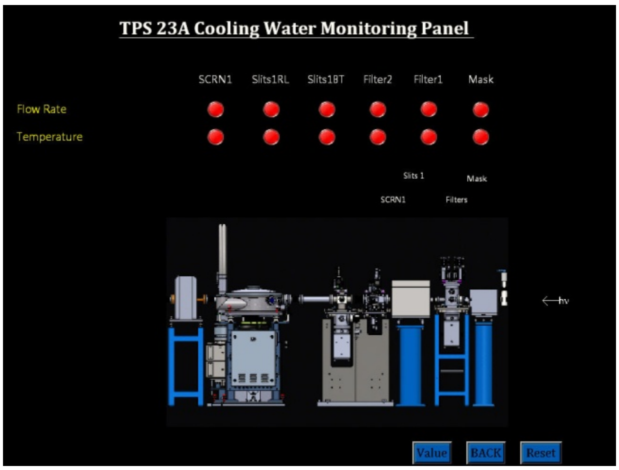

Figure 8: The picture of Cooling Water Monitoring Panel.

In addition, in order to manage multiple temperature and flow values more conveniently, a 12channel paperless recorder was used, and all the necessary states are collectively managed [3-4]. (See Fig. 9).

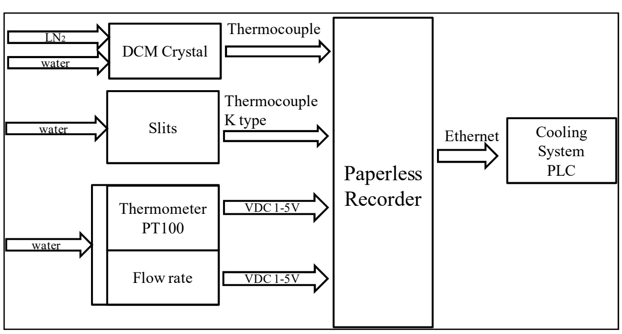

Figure 9: System architecture of Cooling System.

CONCLUSION

This article describes the safety chain system that includes the radiation safety chain system, the vacuum safety chain system, and the cooling chain safety system for achieving the personnel radiation protection and the equipment protection.

Each safety interlock system has signals monitored by another safety interlock system to prevent the signals being misjudged by an abnormal single system influencing the total safety chain system.

ACKNOWLEDGEMENT

We would like to thank the staffs at NSRRC, especially those in the Beamline Group, for assistance in this project.

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