High Speed Interlock System for the SPring-8 Beamline.

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1. Introduction

In the Spring-8 beamline, there are some cases that photon beam should be rapidly stopped; irradiation of synchrotron radiation (SR) to a vacuum chamber wall; a large vacuum leakage, etc. In such cases, RF power supply to the accelerating cavities is stopped by Beam Abort System (BAS)[1].

BAS consists of eight Beam Interlock Modules (BIMs) [2], which are linked each other with photo-fiber cables. The BIMs are installed at the Safety PLC racks around the SPring-8 Storage Ring, and given the Beam Abort Request from the nearest beamline or other systems. The BIMs don't only stop the RF supply, but also inform to the safety PLC where the accidents happen.

2. Beam Abort Requests in the SPring-8 Beamline

At a beamline, there are three types of Beam Abort requests. They are derived from the components as follows;

(1) Interlock X-ray monitor(ILKM)
(2) Fast closing shutter (FCS)
(3) Beamline interlock PLC (BL-PLC).

The Beam Abort Requests are collected in a tool (LATCH box) which can latch the status. After that, an alarm signal is immediately sent to the nearest BIM by line driver. Each of the beamlines has one LATCH box at the BL-PLC rack. The logic diagram of LATCH box is shown in Figure 2. The LATCH box's status is also informed to BL-PLC, so that the information of the accidents can be known by users. The details of the beam abort requests are shown below.

1 Interlock X-ray monitor

The direction of the synchrotron radiation (SR) beam from the insertion device(ID) might be changed by miss-steering of the electron beam in the Storage Ring. In these cases, the SR beam will hit the beam pipes or the other components which do not have heat-proof structures. Therefore the front-end should have an interlock system in order to abort the electron beam in the Storage Ring immediately. The interlock X-ray monitor[3] is designed to detect miss-steering of the SR beam excess the acceptance and send a interlock signal to the BAS.

The diagram of the Interlock X-ray monitor signal processing is shown in Figure 1. The monitor head is electrically floated on bias voltage(0~-1kV) by use of isolation amplifier(ISO122:Bar Brown). The threshold of the current signal is valuable(0~10mA). The time-constant of the current-voltage converting is 50μs, which is short enough to protect vacuum chamber from ID photon beam irradiation. (The metal is supposed to be melted in a few millisecond in the most pessimistic case that the ID beam hit it at a right angle.[3]) When the signal from the monitor is beyond the threshold, the interlock signal is immediately sent to LATCH box. These processes are realized by use of a tool, Interlock signal generator[4].

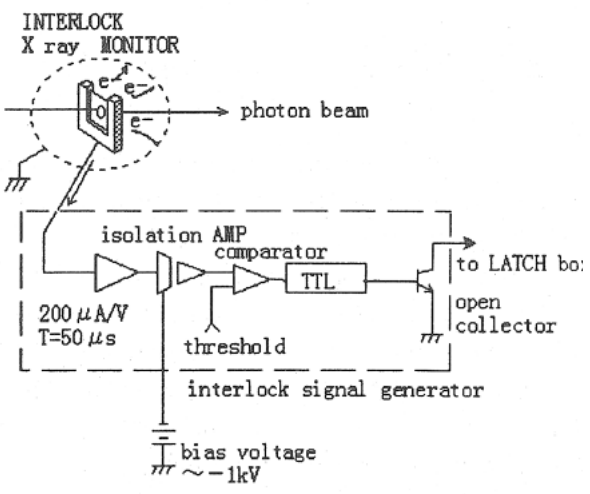

Figure 1 The electronics for Interlock X-ray monitor signal processing

2 Fast closing shutter

FCS is the component which is installed at the up-stream of the beam line front-end. When vacuum conditions of the front-end become worse beyond the threshold, FCS should be rapidly closed. At the same time, the BAS should be driven to protect the FCS from direct hitting of photon beam, because FCS does not have heat-proof structures.
Each of the beamlines has one FCS controller [5], which generates the trigger signal for FCS closing. This trigger is generated 0.5 millisecond before the FCS starts to close. And 8 millisecond after that, the FCS completes closing. Therefore, the trigger signal is fast enough to apply BAS for the protection of the FCS itself. Therefore, the trigger signal is also sent to BAS through LATCH box. In this case, it is required to beam abort within 0.5 millisecond after the trigger is generated.

3 BL-interlock-PLC

There are other Beam Abort Requests in the SPring-8 beamline. For an example, status of the beam DUMP switches are also sent to the LATCH box through the BL-PLC.
The other Beam Abort Requests are prepared for human-body safety rather than for instruments safety, and BL-PLC has another Beam Abort Line by itself, which is moderate speed beam dumping system. Therefore, the Beam Abort signal from the BL-PLC to the BAS is prepared to improve the reliability of the human safety system.

3. Estimation of the delay time

The signal of the Interlock X-ray monitor is sent from the front-end to LATCH box with 40 m cable, and the delay time of this is 0.3μs. The delay time of the electronics in the Interlock signal generator and LATCH box is about 80μs and 12μs respectively. The interlock signal of LATCH box is sent to a BIM with 200m cable, and the delay time is 1.2μs. The fiber network of BIMs is about 1.5km in length, and the delay time is 7.5μs. The delay time of electronics in a BIM is 6μs. When a BIM sends a beam abort request to a RF interlock module at RF station, the duration of the beam abort process is about 100μs [6]. Therefore, total delay time from the interlock X-ray monitor to Beam Abort completing is sum of all these time(about 200μs). In the case of the FCS, the total delay time is about 120μs.
As mentioned above, the BAS is required to have short response time for protection of the beamline component (<1ms for Interlock X ray monitor, and <0.5ms for FCS). Then, we think that the response time of this system will meet our purpose .

Reference

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[2] T.Takashima et.al. in this volume
[3] H.Aoyagi,H.Sakae,H.Kitamura, SPring-8 Annual Report,2,185(1995)
[4]manufactured by TSUJI ELECTRONICS co.
[5] manufactured by VAT co. ltd.
[6]M. Hara et.al. RIKEN Eng. Note RF-011-92, (1993)

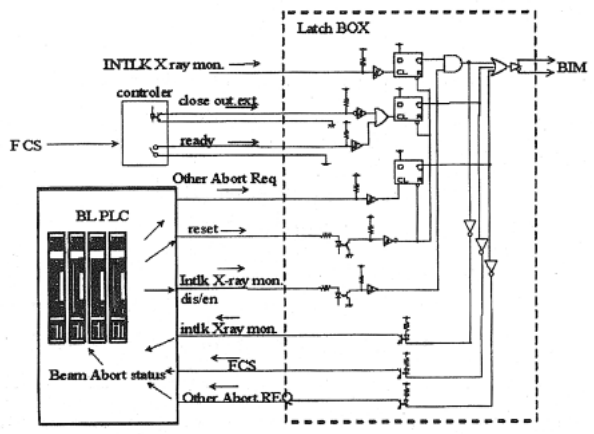

Figure 2 Logic Diagram of LATCH box