Beam Position Alarm: ID Radiation Interlock System using rf-BPMs

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1. Introduction

In the third-generation high-energy storage ring SPring-8, the power density of the synchrotron radiation (SR) emitted from the Insertion Device (ID), comes to be a few 100kW/mrad^2. If the direction of the SR beam happens to be changed by mis-steering of the electron beam, etc., the possibility exists for the SR beam to hit the vacuum pipe or other components without a heat-proof structure. Therefore, each ID beamline must be equipped with an interlock system, in order to abort the electron beam and avoid such accidents.

For this purpose, we had prepared a high-speed interlock system [1] using an Interlock X-ray Monitor at the front end of the beamline. However, there was a problem with the system. More specifically, the monitor signal depends on the SR spatial distribution, and the measured position would change with the ID gap without any movement of the beam. To overcome this problem, we developed another system to be independent of the ID gap.

In the new system, we use rf beam position monitors (rf-BPMs). There are two rf-BPMs at the both ends of each ID in SPring-8 for electron beam position measurement at the straight section. For the interlock system, the beam position is compared with some threshold value. If it exceeds the threshold, the electron beam is immediately aborted.

The threshold value is determined based on the maximum permissible power density of the vacuum chamber, crotch, etc., whose typical values are for the standard in-vacuum undulators.

The beam position value, which is calculated by the electronics of the rf-BPMs, is given to the main component of this system, the Beam Position Alarm (BPA) [3]. In the BPA, the beam position is compared against the threshold, and if it exceeds the threshold, the beam abort signal is sent to the BIM (Beam Interlock Module) [2] through the LATCH box [1] installed in the experiment hole.

2. The Interlock System using rf-BPMs, BPA, etc.

The ID rf-BPM interlock system is shown in Fig.1. The rf-BPMs and their front-end circuits are supplied by Bergoz co. [4], and their sampling frequency is 2kHz. Four beam position signals from the circuit (x, y values of every two BPMs at both ends of an ID) are given to the BPA.

In the BPA, the signals are rectified and compared against the threshold. When one of the four signals (x1, y1,x2 or y2) exceeds the threshold, and at the same time, the ring current is higher than 1mA and the ID GAP is not fully open, then the beam abort signal is sent to the BIM (Fig. 2).

The delay time between the electron orbit shift and the beam abort signal (from the BPA) was measured in an offline test using an RF generator (700 microseconds).

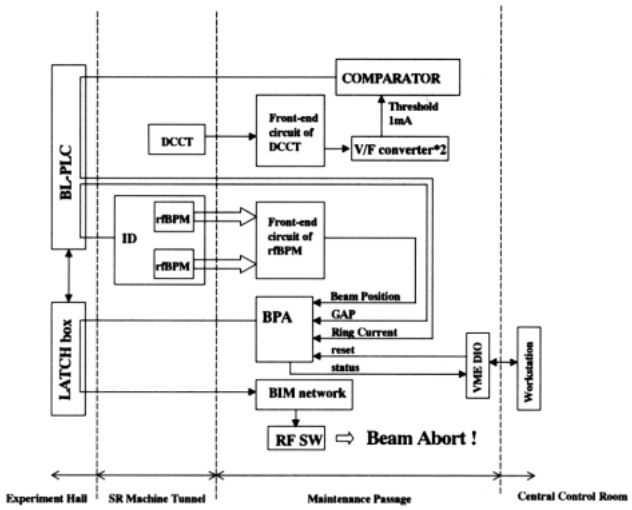

Figure.1 The whole system of the ID rfBPM interlock. The BPA is installed at the maintenance passage, which does not only generate the beam abort signal but also sends some information on the ring current status, beam shift direction, etc., to the workstation.

Another factor of the time delay is the cable and signal operation time of the BIM and the LATCH box, which is approximately less than 50 microseconds [1]. About 100 microseconds (estimated) is needed to abort the electron beam after switching off the RF power of the ring [5], so the total delay is about 850 microseconds. This is short enough to protect the BL components from an SR attack

References

[1] T. Kudo et al., SPring-8 Annual Report ,3, 235, (1996)

[2] T. Takashima et al, SPring-8 Annual Report, 3, 168, (1996)

[3] Manufactured by APOLOMEC, Co.

[4] 01170 Crozet, France

[5] M. Hara et al. RIKEN Eng. Note RF-11-92, (1993)

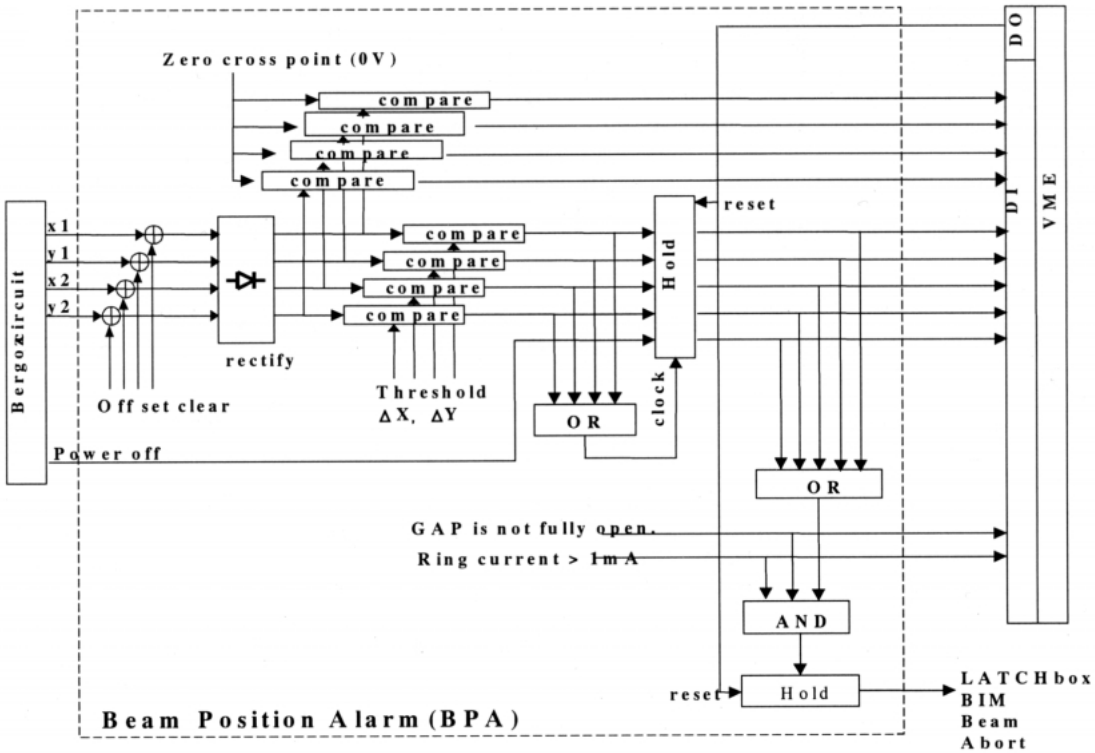

Figure 2. Beam position signals from Bergoz's BPM system, are given to the BPA. The BPA analyzes the signals, informs the status to the workstation, and sends an abort signal to the LATCH box.