BEAM LOSS MONITOR OF IONIZATION CHAMBER TYPE IN KEK PROTON SYNCHROTRON

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A beam loss monitor with 56 radiation detectors of cylindrical ionization chambers was constructed in order to measure the localized beam losses in KEK proton synchrotron for studying the beam injection and the acceleration. Each chamber was mounted at the downstream side of the focusing or defocusing Q-magnet. The beam losses in all chambers are observed in the same time by the equal time signal sampling.

A beam loss monitor using a scintillator-photomultiplier is too sensitive for a strong radiation. And it is difficult to equalize the sensitivity of each detector in such a system. The beam loss monitor using ionization chamber, which is generally utilized as a detector for beam losses[1], has no such troubles.

Fig.1 shows the schematic diagram of the ionization chamber which is filled with "PR-gas" (Ar + $CH_4$10%) of 1 atm. The drift velocity of electron in PR-gas is 5~6 cm/μsec in the electric field of several hundreds volts/cm[2], which is enough to obtain a time resolution of the chamber for observing the time dependence of the beam loss due to the betatron oscillation. High voltage of -500 V is applied to the outer electrode. The shunt resistance R is chosen based on the radiation strength and the desired time resolution. In normal operation R = 2.2 KΩ. The upper limit of the detectable radiation which is restricted by the space charge effect[3] is about 10^5 r/h, which corresponds to the injection to the chamber of the high energy charged particle of 10^{12}/sec and the output current of about 100 μA. The lower limit is restricted by the amplifier noise and the offset drift. Thus it is possible to obtain a wide dynamic range for a beam loss signal.

The blockdiagram of the electronics is shown in Fig.2. The output signal of the ionization chamber is amplified by the pre-amplifier and fed to the signal conditioner which contains the analogue multiplexer of 56 channels to select the signal of the desired chamber and the controller of the sample and hold circuit in each pre- amplifier module. The gain of the amplifier is 20 or 40 dB which is selected by the remote control from the control room. The output signals of the chambers are sampled at an arbitrary timing in the acceleration cycle.

Fig.3 shows the typical beam loss signal and Fig.4 the sampled one at the beam injection timing around the main ring. To examine the feasibility of this system to use as a radiation monitor for the residual radiation in the accelerator room, the radiation dependence of the amplified output of the chamber was measured. The result is shown in Fig.5, in which the shunt resistance of the chamber is R = 5 MΩ. These results indicate that this system could be used as a residual radiation monitor as well as a beam loss monitor.

References
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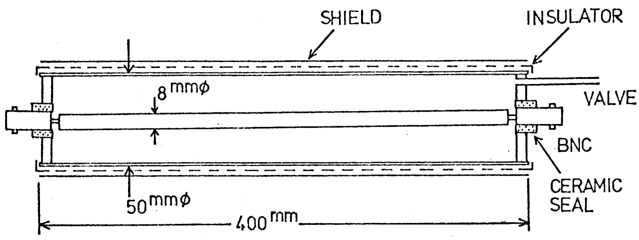


Fig.1 Schematic diagram of ionization chamber.

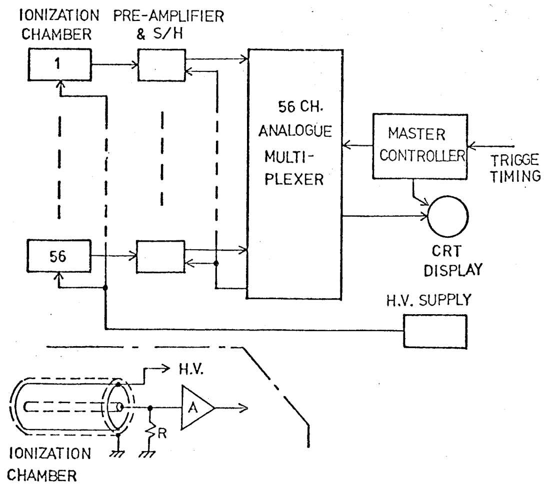


Fig.2 Blockdiagram of electronics.

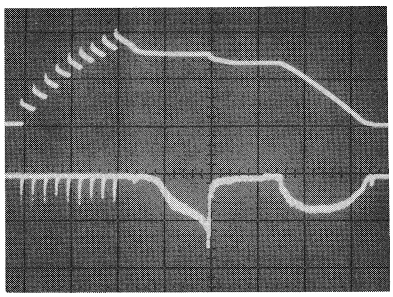
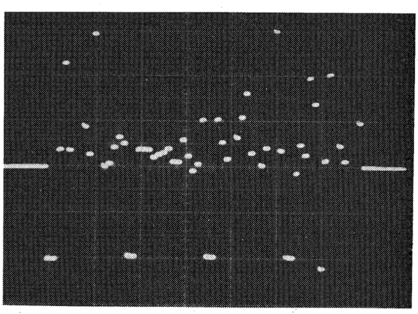


Fig.3 Beam loss signal.
Upper trace;beam intensity.
Lower trace;beam loss signal.



I II III IV
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Fig.4 Beam loss signals around the main ring which were sampled at the beam injection timing.

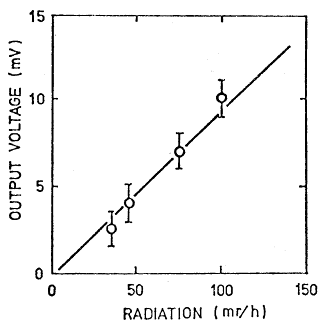

Fig.5 Radiation dependence of the ionizatio chamber output.