BEAM MONITORING SYSTEMS FOR THE ETL STORAGE RING

T.Noguchi, S.Sugiyama, T.Yamazaki,
T.Mikado, M.Chiwaki and T.Tomimasu

Electrotechnical Laboratory

Abstract

The beam position monitors installed in the beam transport system of the 600 MeV storage ring are devices using optical transition radiation[1]. An aluminum plate 0.5 mm thick is positioned in the path of the electron beam by a remote controlled pneumatic cylinder at angle of incidence $\theta = 45^\circ$ and produces transition radiation which is observed with a TV camera.

Informations of beam position and profile are obtained on the TV scope with a spatial resolution of 0.3 mm. The stored current in the ETL storage ring is monitored by a silicon photo diode (SPD) detecting synchrotron radiation (SR). The monitor was calibrated by the single electron decay step method[2].

1. Beam Position Monitor

The beam transport system (BTS) for the 600 MeV storage ring have been constructed and operated since Aug. 1981 for the 300 MeV electron beam injection from the ETL linac. The beam position and profile monitors were developed in ETL and they have been installed in three points in the BTS[3]. At the first stage of the BTS operation, two beam monitors were added to observe positions of the beam extracted to atmosphere through 0.1 mm thick Ti windows at each end of bending sections. Optical transition radiation (TR) emitted by 300 MeV electron beam passing through an Al plate has been utilized for beam position and profile monitoring. The TR beam monitor used in BTS is shown in Fig. 1. Two kinds of Al targets were prepared for beam position measurement.

A 50 μm thick Al foil target (40 mm ϕ) supported in a frame and a 0.5 mm Al plate target on which 10 mm grating was grooved for beam position measurement, were also used as TR radiator. The grating and the circle of the frame were illuminated by a lamp mounted out side of the viewing port to provide level and center of target on TV scope. The minimum beam current observed by the TR monitor was 2 nA pulsed beam of 1.6 pps 1 μs duration. Spatial resolution of the monitors are about 0.3 mm.

2. Stored Current Monitor

The SPD stored current monitor is illustrated in Fig. 2. Photocurrent caused by the SR is converted to voltage using an operational amplifier and indicates beam current on digital panel meters. The monitor enables us to measure stored current in the range between 1 μA and 1.5 A. Calibration of the monitor was performed by simultanious measurement of the SR at different viewing port with a PM monitor or other monitor which has calibrated scale. The PM monitor can clearly detect a variation of the SR intensity caused by one electron loss in stored beam consisting of several hundred electrons. Absolute measurement of the PM anode current for single electron diminution has been performed with in 1 % accuracy.

Fig. 3 shows synchrotron radiation decay steps coincident with an electron loss of stored beam. The beam reduction was achived by means of over excitation of a kicker coil or decrease of RF power for the accelerating cavity. Fig. 4 shows responses of several current monitors used in the ETL storage ring.

References

1) G.M. Caribian; Soviet Physics-JETP 10 (1960) 372, 33 (1971) 23.
2) H.Kitamura; SOR-RING REPORT, 75 No.7 (1977).
3) T.Noguchi et al; Proc. 1981 Linac Meeting in Japan (1981).

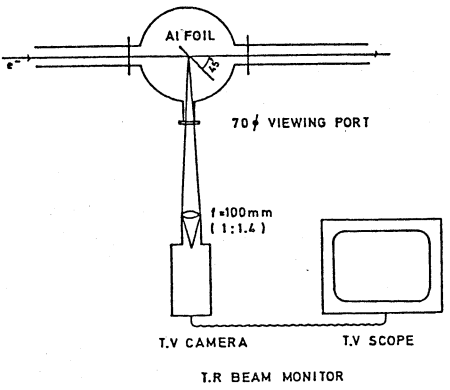

Fig.1 Block diagram of the T.R beam position monitor.

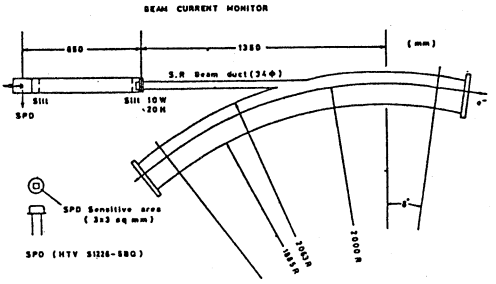

Fig.2 Layout of the SPD stored current monitor.

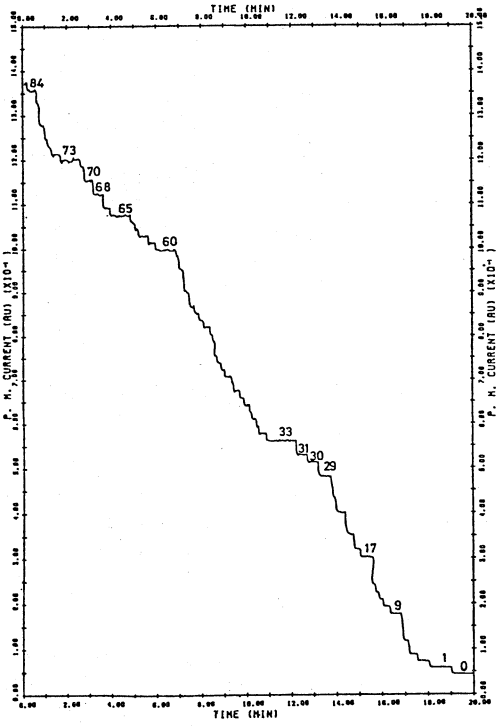

Fig.3 Decay step of SR intensity observed by the PM beam current monitor.

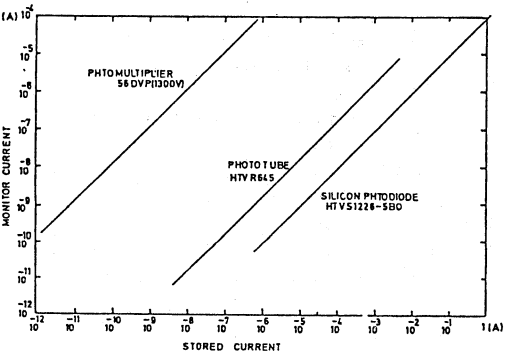

Fig.4 The monitor responses versus stored current.