BEAM MONITORS IN TARN

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Abstract

Several kinds of beam monitors are installed in TARN. A nondustructive beam monitor is necessary for an accumulation ring: A ferrite core monitor and electrostatic monitors are prepared[1]. Destructive monitors, i.e. multiwire, single rod and a scintillation monitors, are also used, as they provides a precise beam profile and position[2].

Ferrite Core Monitor

The phase of a beam bunch is detected by the monitor, and fed to the phase locking system for the RF stacking. Three ferrite cores (382 mm O.D., 260 mm I.D., 20 mm thick) are piled, and two one-turn coils are wound round them in opposite directions for a common mode noise reduction. The monitor is mounted surrounding a vaccum duct with a ceramic ring as shown in Fig. 1. Figure 2 shows the signal of an injected beam.

Electorstatic Monitor

This monitor is designed to observe the phase and the position of the beam. It consists of a pair of electrodes and shiels as illustrated in Fig. 3. The electrode and the inner shield form a capacitor of 180 pF, and the induced voltage between them is measured with a 100 kΩ FET probe followed by an amplifier. Figure 4 shows beam bunches detected by this monitor.

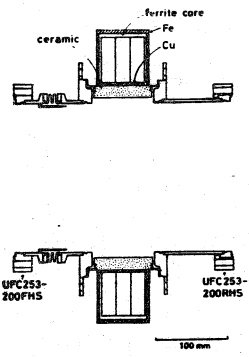


Fig. 1 Mounting of the ferrite core monitor. The shield is additively covered with a copper plate and wrapped with aluminum foil.

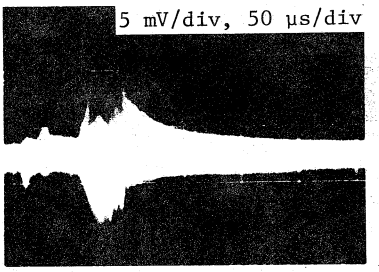


Fig. 2 The ferrite core monitor detects a 7 MeV/u H_2^+ beam injected by the multiturn method.

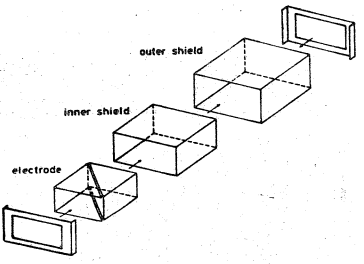


Fig. 3 Structure of the electrostatic monitor.

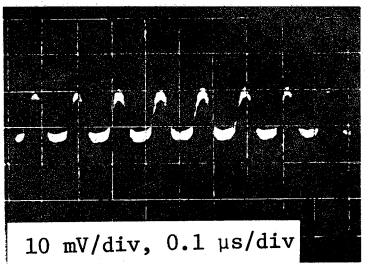


Fig. 4 Bunches of a H_2^+ beam 60 μs after the injection. The monitor is the electrostatic one. About 5×10^7 ions are contained in a bunch.

Noise Reduction

As it is difficult to reject the RF noise, synchronizing with the beam signal, the S/N ratio is improved by extracting a harmonic of a higher order in the beam signal. In contrast to the RF noise, the beam signal contains higher order harmonics as shown in Figs. 5 (a) and (b). A resonator for the third harmonics is used against the RF noise. Figure 6 shows a beam bunched by the RF field. The monitor is the electrostatic one.

Multiwire Monitor

The chamber consists of 16 beryllium copper ribbons, 60 × 2 × 0.5 mm , fixed on a ceramic frame with a 1 mm spacing. It is displaced by a driving apparatus with a pulse motor. The electric charges in each ribbon are transfered and stored in a concenser in a read-out circuit, and the voltage is measured. Figure 7 shows the horizontal profile of an injected beam.

Single Rod Monitor

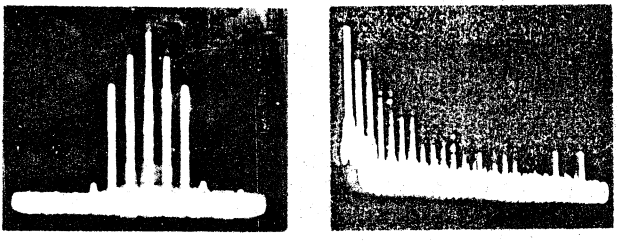
The senser of the monitor is a beryllium copper rod of 3 mm in diameter. Disturbing the beam less than a multiwire monitor, this is suitable ofr observing the profiles of a beam injected by multiturn and a stacked beam. The senser is attached to a driving apparatus with a pulse motor or an air cylinder.

Scintillation Monitor

A 5 mmϕ rod of plastic scintillator, of which the surface is processed with vacuum evaporation of aluminum, is attaced to a driving apparatus with an air cylinder. This monitor is efficient to detect a beam of reduced intensity long after the injection.

References

1. N. Tokuda, T. Katayama, H. Tsujikawa and M. Yoshizawa, "Multiwire and Single Rod Beam Profile Minotors in the TARN", INS-NUMA-19, 1980.
2. N. Tokuda and S. Watanabe, "Electrostatic and Ferrite Core Monitors in the TARN", INS-NUMA-21, 1980.



Figs. 5 (a), (b) The spectra of the RF noise (a, left), and of the beam signal (b, right). Spectrum lines appear at every 8 MHz.

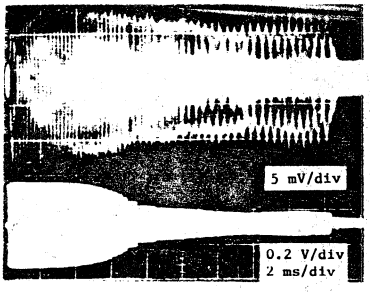


Fig. 6

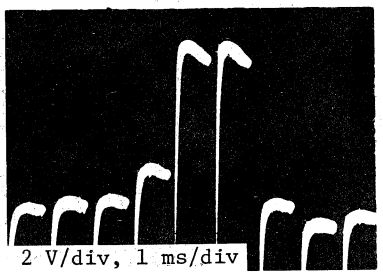


Fig.7