MULTITURN INJECTION TO TARN

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Introduction

A combination of multiturn injection and RF stacking method[1] has been used in TARN.[2] In this method, heavy ions from the SF-cyclotron are injected in the betatron phase space via a magnetic and an electrostatic inflectors while are excited two pulse magnets, and then, stacked in the synchrotron phase space by an RF field. This injection scheme is very efficient for obtaining higher beam intensity.

Multiturn Injection

In the multiturn injection method a bump in the closed orbit is produced by two pulse magnets. A schematic setup for this method is illustrated in Fig. 1. The bump magnets are located up-and downstream from the injecting position, and the distance between them is a half of a betatron wave- length in order to avoid any effect on other parts of the equilibrium orbit. The distorted equilibrium orbit is moved from a position of the inflector septum to the inner part of the ring while the beam is injected, and the amplitude and the collapsing rate of the distortion determine an intensity and a betatron amplitude of the injected beam. Figure 2 is a calculated phase diagram of the multiturn injection scheme, where the radial betatron wave number is assumed at 2.25.

The bump magnet is shown in Fig. 3. This magnet yoke is made of ferrite, and the pole is 400 mm in length, 200 mm in width and 50 mm in the gap height. A two turn coil can generate a magnetic field with the maximum field strength of about 500 Gauss and with a falling time of 20 ~ 40 μs. The current waveform supplied to the magnets is shown in Fig. 4.

Figure 5-a shows the injected α beam of 7 MeV/u, detected with an electrostatic monitor, when the bump magnets are not excited. This beam hits against the inflector septum after several turns and cannot be captured on the equilibrium orbit. Figure 5-b shows the change of beam intensity when the multiturn injection is performed by exciting two bump magnets. The beam intensity is increased to 20 times comparing with the one in the single turn injection. Decrease in the elecrostatic monitor signal after the multiturn injection is due to the debunching of the beam. The beam profile after the multiturn injection is detected by a destructive intensity monitor and is shown in Fig. 5. Beam width and emittance are measured at about 35 mm (FWHM) and 153 mm·mrad, respectively.

References

1) T.Katayama and S. Yamada, "Injection and Accumulation Method in the TARN", INS-NUMA-12 (1979).
2) Y. Hirao et al., "Test Accumulation Ring for NUMATRON Project -TARN-", INS-NUMA-10 (1979).

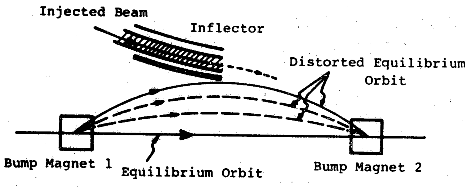

Fig. 1. Schematic setup for multiturn injection method.

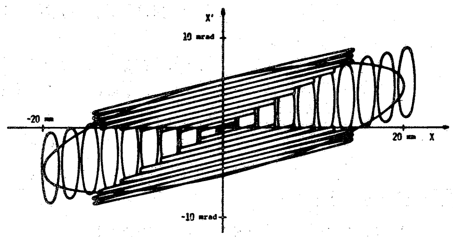

Fig. 2. Phase diagram of multiturn injection Scheme.

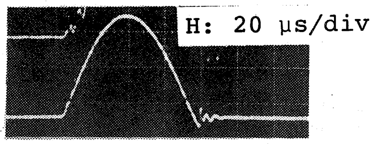

Fig. 4. Current waveform supplied to bump magnet.

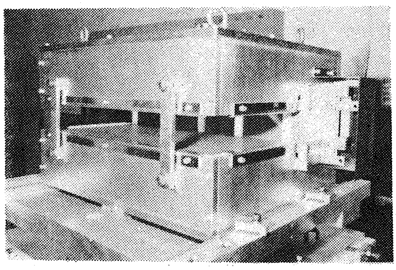

Fig. 3. Bump Magnet

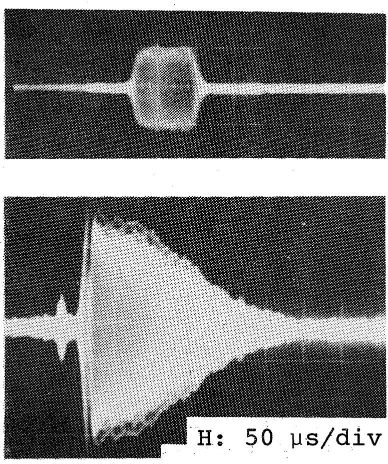

Fig. 5. a) Injected beam when bump magnets are not excited.
b) Multiturn injection beam.

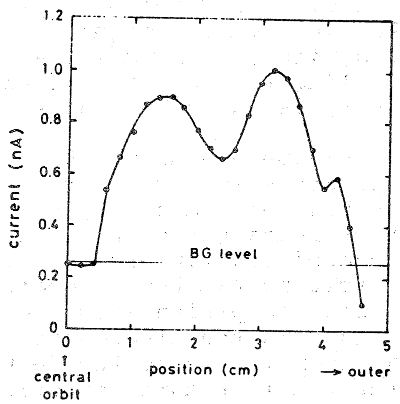

Fig. 6. Beam plofile