INJECTION METHOD OF THE NUMATRON

T.Katayama and S.Yamada

Institute for Nuclear Study,
University of Tokyo

Abstract

A combination of multiturn injection and RF stacking will be applied to the NUMATRON storage ring. Some injection schemes and intensity gains obtained from them are described.

1. Introduction

The NUMATRON is designed to provide heavy ions up to uranium in an energy range of 100 $\sim$ 1000 MeV per nucleon. Such capability can be achieved by an accelerator complex which has a synchrotron at the final stage. In order to obtain an expected high-intensity beam, a storage ring is installed between an injector linac and the synchrotron. This ring has almost the same radius and structure as of the synchrotron and forms a two-ring system together with the synchrotron. This system will bring about a variety of injection and acceleration modes.

In this report, the methods of multiturn injection combined with RF stacking are described.

2. Four-Turn Injection

Since the ν-value of the ring is 6.25, the four-turn injection is the most advantageous for preventing the electrostatic inflector from a bombardment of the injected beam. In this case, the fields of the bump magnets have to be diminished abruptly to zero just before the injected beam completes four revolutions.

The acceptance required for this scheme is eight times of the beam emittance, and about a half of the acceptance is filled by the beam. Assuming that the emittance of the injector beam is 4π mm·mrad, the required acceptance and half aperture become 32π mm·mrad and 10.9 mm, respectively. In this estimation, the values of 3.69 m and -0.895 are used for the β- and α-functions at the inflector position. The corresponding phase diagram is shown in fig.1.

The injected beam is, then, captured in the stable region of the RF acceleration and is stacked in the synchrotron phase space. Using the values of 1.96 m for the dispersion function, 136.6 mm for the available aperture in the bending magnets, and 2.95×10^{-4} for the momentum spread of the injector beam, the number of RF stacking is estimated at 160. The total intensity gain is 640.

3. Multiturn Injection

It is possible to increase the filling factor of the acceptance, if the vacuum problem caused by the beam bombardment onto the inflector is surmountable.

In the case of an exponential decay of the bump-magnet fields, the intensity gain I/I_0 is deduced as shown in fig.2. The abscissa of the figure is the half aperture required for the injection. The combination with the RF stacking gives the intensity gain as shown in fig.3.

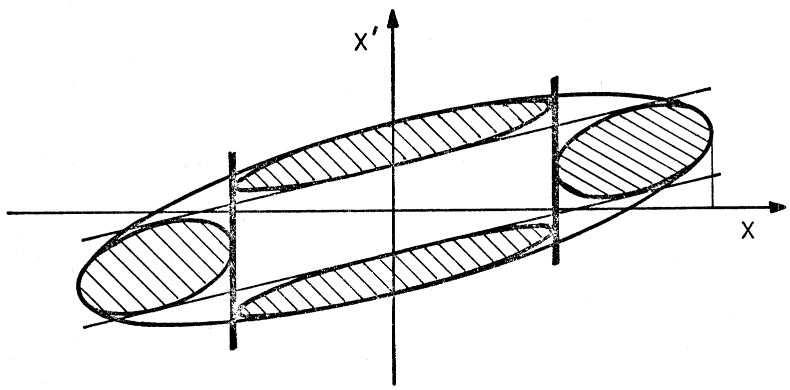

Fig.1. The phase diagram of the four-turn injection. The septum thickness and beam emittance are assumed at 0.2 mm and 4π mm·mrad, respectively. The acceptance required for this scheme is 32π mm·mrad.

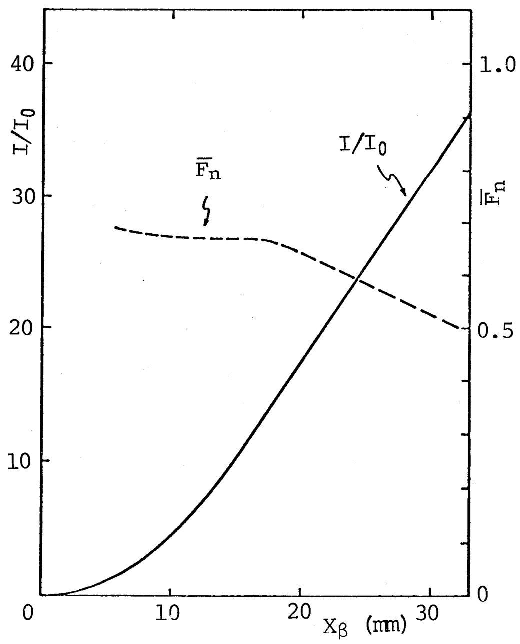

Fig.2. The intensity gain obtained by multiturn injection only. The abscissa is half aperture required for injection.

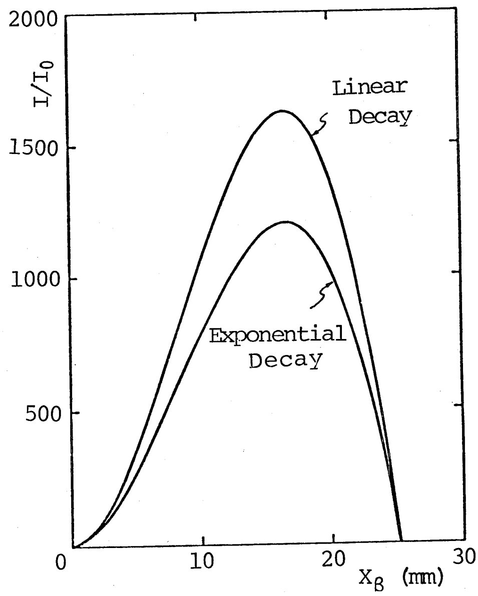

Fig.3. The total intensity gain obtained by the combnation of multiturn injection and RF stacking.