THE EVALUATION OF RF STACKING EFFICIENCY BY THE NUMERICAL CALCULATION

T. Murakami

Institute for Nuclear Study, University of Tokyo
Tanashi, Tokyo 188, Japan

Abstract

RF stacking efficiency is evaluated by the numerical calculation. Capture efficiency is obtained to be about 92%, and dilution in the stacking orbit is also estimated.

Introduction

The evaluation of RF stacking efficiency by the numerical method was performed. The two points are mainly examined; the loss of the particles while they are moved from the injection orbit to the stacking orbit (Capture Efficiency), and the influence by the RF voltage which the particle in the stacking orbit are had (Dilution).

The process of the calculation are as follows.

° The initial values (Phase and kinetic energy) of one particle are supposed.

° The energy gain after passing through the RF accelerating gap is calculated from the phase and RF voltage using

$$\Delta E = \varepsilon eV \sin\phi .$$

° The amount of the phase change while the particle turn round in the ring is estimated from momentum compaction, momentum of the particle and RF frequency from the relation as

$$\frac{d\tau}{\tau} = \left(\frac{1}{\gamma_{tr}^2} - \frac{1}{\gamma^2} \right) \frac{dp}{p} .$$

These steps are reiterated for many times and for variable initial conditions.

Capture Efficiency

The RF voltage shown in Fig. 1 is supposed. The RF bucket area is held constant during the period from t_1 to t_4. The parameters are chosen to be fit for the case of TARN. 1800 particles of 8MeV protons with the energy spread of ±8keV are uniformly distributed in the injection orbit at the beginning. Then the RF voltage is applied and the particles are transported to the stacking orbit. Fig. 2 exhibits the particle distribution in the course of the calculation. Finally, 92% in the injected beam is carried to the stacking orbit.

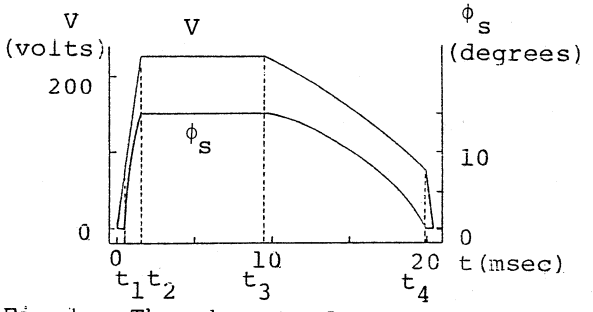

Fig.1. The change of RF voltage and synchronous phase.

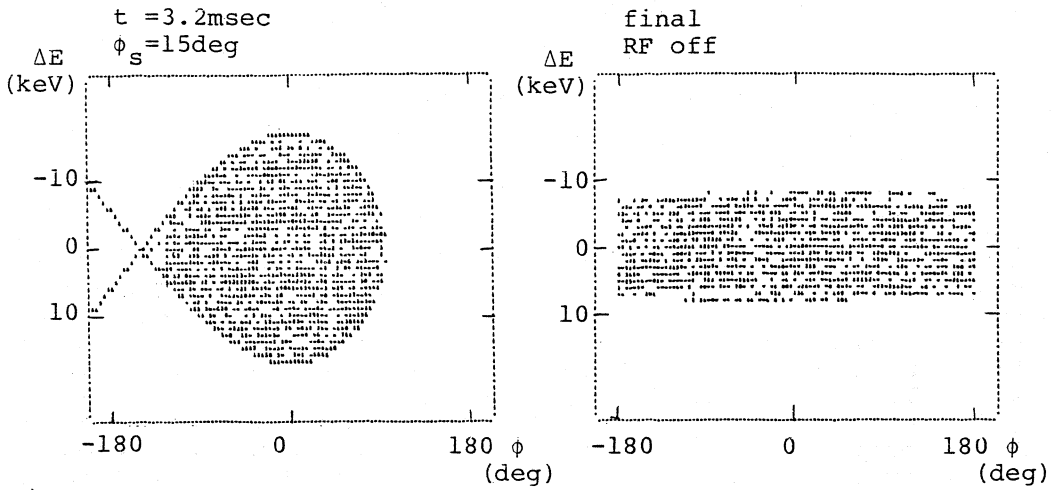

Fig. 2. The particle distributions in the course of calculation of capture efficiency. The shape of RF is also displayed. The center of the figure means the phase and energy of synchronous particle.

Dilution

The particles which stored in the stacking orbit are diffused by the RF bucket. As a result, not only the energy of the particles is shifted but also the width is broadened. The beams are supposed to be initially distributed in the top (Fig. 3(a)) and bottom (Fig. 3(b)) of the stacking orbit. Since the height of the RF bucket is large at the bottom, the broadening is large in the later case.

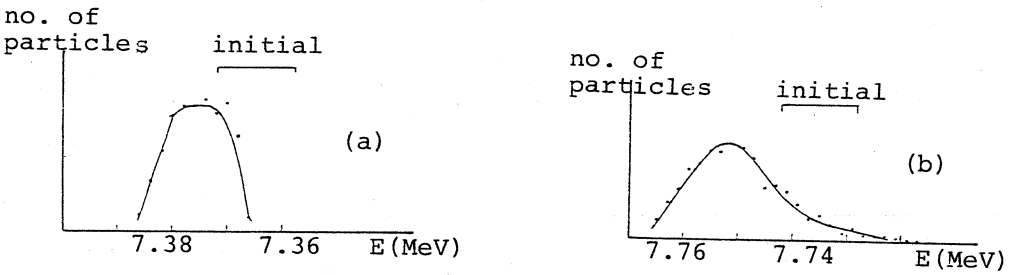

Fig. 3 Showing the dilution of the particles in the top (a) and bottom (b) of the stacking orbit. The particles are initially distributed in uniform density. The points show the calculated results and the curves are only guides to eyes.