A POP EXPERIMENT SCENARIO OF INDUCTION SYNCHROTRON AT THE KEK 12GEV-PS

K.Takayama, J.Kishiro, K.Koseki, K.Torikai, E.Nakamura, T.Toyama, Y.Arakida, M.Wake, H.Sato, M.Shirakata, S.Igarashi, and Y.Shimosaki, M. Sakuda, D. Iwashita, KEK, Tsukuba, Ibaraki 305-0801, Japan

K. Horioka and M. Shiho, Tokyo Institute of Technology, Nagatsuda, Kanagawa 226-8502, Japan

Abstract

A scenario for the first POP experiment and crucial issues of accelerator operation with induction acceleration are discussed.

INTRODUCTION

This is a plan to demonstrate the concept of the induction synchrotron [1] in the KEK 12GeV PS. In this proof-in-principle experiment, the acceleration and longitudinal beam confinement will be performed by employing induction accelerating devices instead of conventional RF devices. The induction device unit, consisting of DC power-supply, pulse-modulator with solid-state switching elements, and 2.5kV induction accelerating cavity, has been developed at KEK since 2000 [2]. A required number of units will be installed along the beam line. Experiments will be done sharing the machine time with the K2K experiment and other fixed target experiments during the time period of 2003-2008. As a first step, a single RF bunch will be accelerated with induction acceleration.

SCENARIO OF INDUCTION ACCELERATION

A proton bunch, which is accelerated in the 500MeV booster synchrotron, is injected into the 12GeV main ring, which is waiting for the bunch with the RF buckets. The RF bucket captures the bunch. This RF bunch is accelerated with induction voltage, which is synchronized with the lumping pattern of guiding magnetic fields. A super-imposed induction voltage of 10kV is generated in the four induction gaps, each of which is capable of generating 2.5kV. At the transient stage of the beginning of acceleration, the magnetic fields have a parabolic lumping pattern. The four induction devices are independently triggered following a programmed trigger pattern with a constant output voltage of 2.5kV. During the constant acceleration stage, these four induction devices are simultaneously triggered. A finite droop in the induction voltage is inevitable because of finite inductance and circuit resistance. From a point of longitudinal beam dynamics, the droop takes a role of an additional gradient force in the RF confinement. In the other word, the droop leads to a parabolic potential in the longitudinal phase space; the resulting confinement force is a super-impose of the sinusoidal wave force and this linear gradient force. Before the transition energy, the few percent droop gives an additional confinement force, while it somewhat reduce the focusing beyond the transition.

HARDWARE

Four induction cells are installed in the short-straight section of IV-3D. Each of cells is energized with a corresponding pulse modulator through a matching high voltage cable. The induction cell is estimated to generate heat of approximately 15kW assuming the operation cycle of 4 sec (acceleration period of 2sec). The magnetic core is forcibly cooled with insulation oil. The induction cell is connected with a ballast resistance of 200 Ω to minimize reflection due to mismatching. All deposited heat on the devices is removed with pure cooling water. The modulator connected with a DC power supply is placed in the power-supply yard on the ground level. Since the device is essentially a pulse device, noise shield should be crucial.

SCHEDULE

The POP experiment will be performed in the following schedule. Beyond the first step, the second and third step are scheduled, where a super-bunch trapped in the induction barrier bucket will be accelerated to 12 GeV.

Table1: Road map of the POP experiment

Year	‘03	‘04	‘05	‘06	‘07
Step 1	⟶				
Step 2		⟶	super-bunch (SB) handling		
Step 3	acceleration of SB		⟶		

The POP experiment is supported by Grant-In-Aid for Creative Scientific Research (KAKENHI 15GS0217).

REFERENCES

[1] K.Takayama and J.Kishiro, “Induction Synchrotron”, *Nucl. Inst. and Meth.* **A451**, 304-317(2000).

[2] http://www-accps.kek.jp/Superbunch/index.html

[3] K.Koseki et al., ” R&D Works on 1MHz Power Modulator for Induction Synchrotron ” , to be presented in PAC2003.

[4] K.Torikai et al., ” Design Study of 1 MHz Induction Cavity for Induction Synchrotron ” , to be presented in PAC2003.