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INJECTOR ADJUSTMENT OF PNC HIGH POWER LINAC

Y.L.Wang, Y.Yamazaki, K.Hirano, Y.Tanimoto, S.Toyama, T.Emoto, and I.Sato*

Oarai Engineering Center (OEC)
Power Reactor and Nuclear Fuel Development Corporation (PNC)
4002, Narita-cho,Oarai-machi, Ibaraki-ken,311-13, JAPAN
*, Atomic Energy Research Institute, Nihon University
Shurugadai 1-8, Chiyodaku, Tokyo 101, JAPAN

ABSTRACT

The first and second steps test of the injector of PNC high power linac are described.
First step, first beam (3.1Mev 100mA with pulse 20μs 1Hz) had been accelerated successfully in this year March by buncher and accelerator sections.
Second step, the chopper and prebuncher systems were added between the gun and buncher. The chopper cavity which resonated at two modes smoothly past the high power and beam test. It shows that such kind chopper system is easy to adjust.
Third step, high duty beam (100mA with 4ms 50 Hz) will be accelerated at the beginning of next year.

1. INTRODUCTION

The injector of PNC high power electron linac [1] consists of the gun, chopper cavity, chopper slit, prebuncher, buncher, No.1 accelerator section and beam dump. Fig.1 shows the injector system of PNC high power linac. Fig.2 shows the RF system of injector. A half power from 1MW klystron goes to the high power dummy load and another half power energizes No.1 accelerator section and buncher by 3dB power divider. In the buncher branch, a small part of power will energize the prebunching cavity and chopper cavity. Each branch has a phase shifter and attenuater.

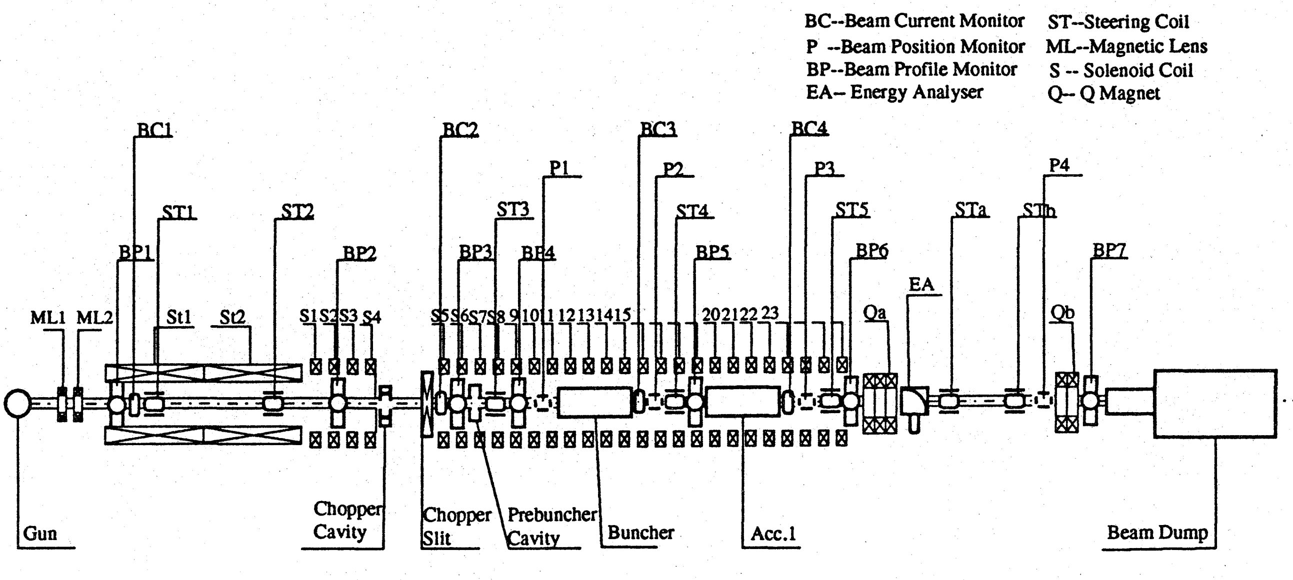

Fig.1, Injector of PNC High Power Linac

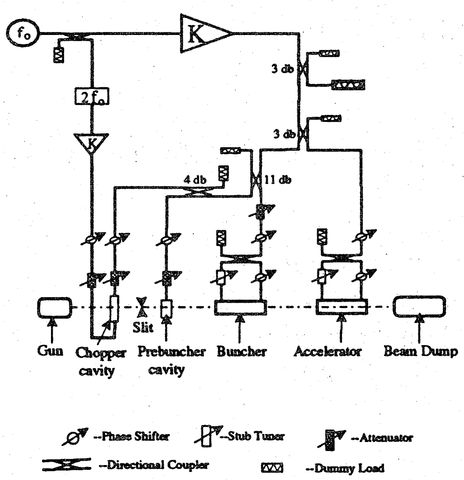

Fig. 2, RF system of the injector

2. FIRST BEAM ACCELERATOR

The first beam (100mA with pulse 20μs 1Hz) was accelerated to 3.1 Mev by buncher and No.1 accelerator. The energy spectrum was not so good, but it was easy to accelerate the beam only adjusted the phase between the buncher and accelerator sections. During that test, in the ring all stub tuners positions could be kept the same as low power test. The reflections without and with beam in the ring were not so large different.

3. SECOND STEP ACCELERATOR BEAM

To get high duty, high beam current, small energy spread and low beam emittance, the chopper system with new idea [2] and the prebuncher are adopted in the injector of PNC linac. The phase relationship of the beam bunch and RF field in the injector is shown on Fig.3.

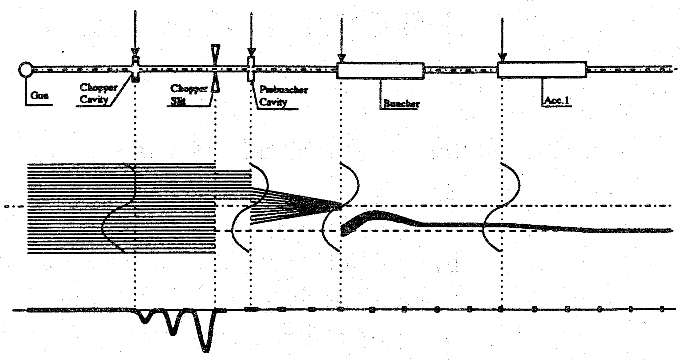

Fig. 3 The phase relationship of the beam and RF field in the injector

3-1. CHOPPER SYSTEM

For normal one cavity chopper system, the longer beam buncher passed the chopper system, the larger transverse momentum added and the worse emittance. But for the new idea, let TM210 mode resonate at fo and TM410 mode at 2fo in one cavity, until 120 degree buncher length there was no additional transverse momentum added. Fig.4 shows after chopper slit the beam profile during the chopper system adjusting: a) - without RF signal, b) - with fo signal, c) - added DC magnetic bias, d) - with fo and 2fo signals and e) - set slit equal to beam diameter. Adjusting the ratio of fo and 2fo rf power and 2fo phase, 120 degree flat waveform shown on Fig.5 could be seen by means of CSA803 (Communication Signal Analyser).

3-2. PREBUNCHER

Because the prebuncher cavity is located after the chopper, beam induce field must be canceled by detuning the cavity. For 100mA beam current

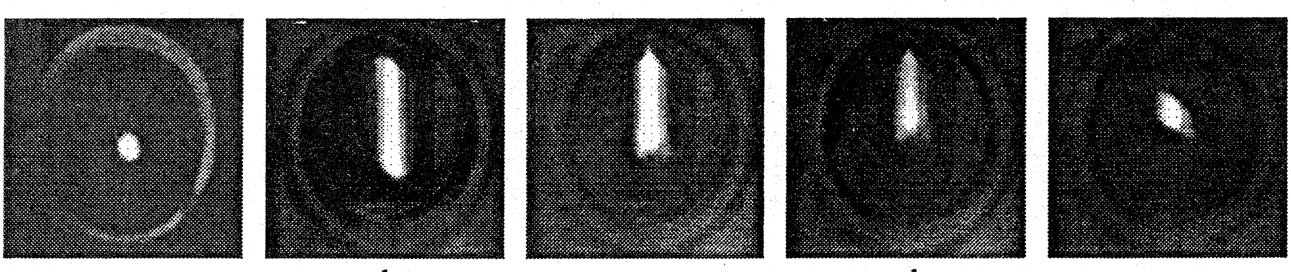

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Fig. 4 Beam profile change during the chopper system adjusting

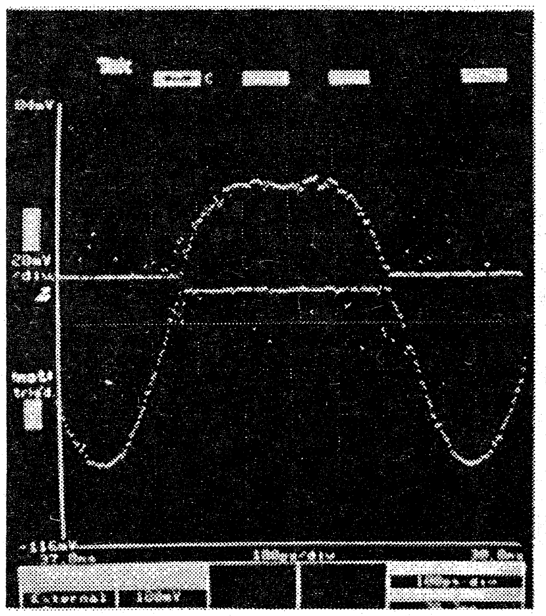

Fig. 5 Waveform with fo and 2fo signal in chopper cavity

the cavity was detuned about 0.4MHz. The amplitude and phase in the prebuncher cavity could keep the same as I=0. Fig.6 shows the detuning course: a) - I=0, b) - I=100mA before detuning, c) - I=100mA after detuning.

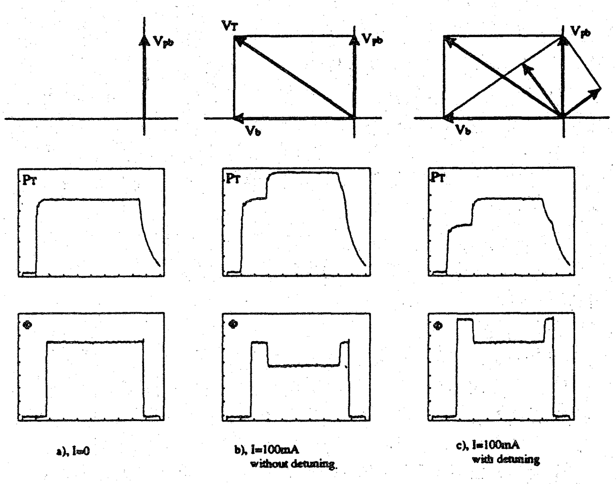

Fig.6, Prebuncher Cavity Detuning

4. RESULTS AND SUMMARY

Fig.7 shows the beam current in each beam current monitor. It shows that 300mA beam current (with pulse length 3ms and 0.1Hz) from gun, one third of beam current past the chopper system and was accelerated. The energy spectra measured by the first step and second step were shown on Fig.8. The second one is much better than first one, $\Delta E/E$ is about 1.5%.

During this test, matching and tuning the accelerator with the traveling wave resonant ring were not so difficult. Adjusting stub tuners in the resonant ring could compromise both reflections with and without 100mA beam loading.

It has already been realized in the new chopper system that TM210 mode resonated at frequency fo and TM410 mode resonated at frequency 2fo in one cavity, and it is easy to adjust. After emittance measured it will be shown such kind chopper system is a desirable one.

References

[1], Y.L. Wang,et al."Design of High Power Electron Linac at PNC". Journal of Nuclear Science and Technology, 30[12], Dec.1993. pp1261-1274.

[2],Y.L. Wang, et al."A Novel Chopper System for High Power CW Linac" Proceedings of the 1994 international Linac Conference, in Tsukuba, Japan, Aug. 1994. P 205.

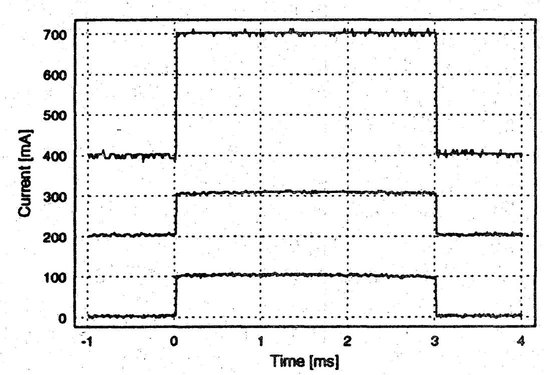

Fig.7, Beam Current in each current monitor

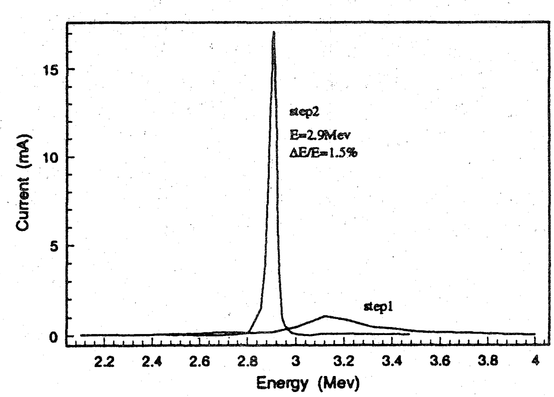

Fig. 8, Energy Spectra of the Injector