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A SINGLE PREBUNCHER CAVITY RESONANT AT FUNDAMENTAL AND HARMONIC WITH HIGH CAPTURE EFFICIENT

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ABSTRACT

A new prebuncher system is mentioned. It has high capture efficient. There is only one prebuncher cavity which TM110 mode resonated at the fundamental frequency fo and TM310 mode resonated at second harmonic frequency 2fo.

1. INTRODUCTION

For PNC high power CW linac, its beam energy is 10MeV, beam current 100mA, energy spread lower than 1.0% and bunch width lower than 5°[1]. The injector consists of a electron gun, chopper, prebuncher, buncher and one accelerator section. The beam from electron gun is 300mA at 200kV. After chopper system, in one RF period only 120° bunch length passes through the chopper slit. The 120° bunched beam enters the prebuncher bunched to 20°. It means that a huge amount beam power (200mA 200kV) will loss on the chopper slit. It will cause a big heating dissipation problem.

In principle a normal prebuncher cavity can bunch beam from about 120° to 15°. It is shown on Fig.1. Its capture efficient is about 33%. If the field in the cavity is not a sinuous wave but a saw-wave, it will be a ideal prebuncher shown on Fig.2 , one period 360° beam can be bunched in 15°. Its capture efficient is 100%. But it is very difficult to make such field.

Some laboratories use the fundamental and second harmonic to increase beam capture efficiency[2,3]. But they used two cavities that one is resonated at the fundamental frequency *fo* and another is at second harmonic frequency *2fo.* We had already developed single chopper cavity resonated at the fundamental frequency *fo* and at second harmonic frequency *2fo*[4,5].

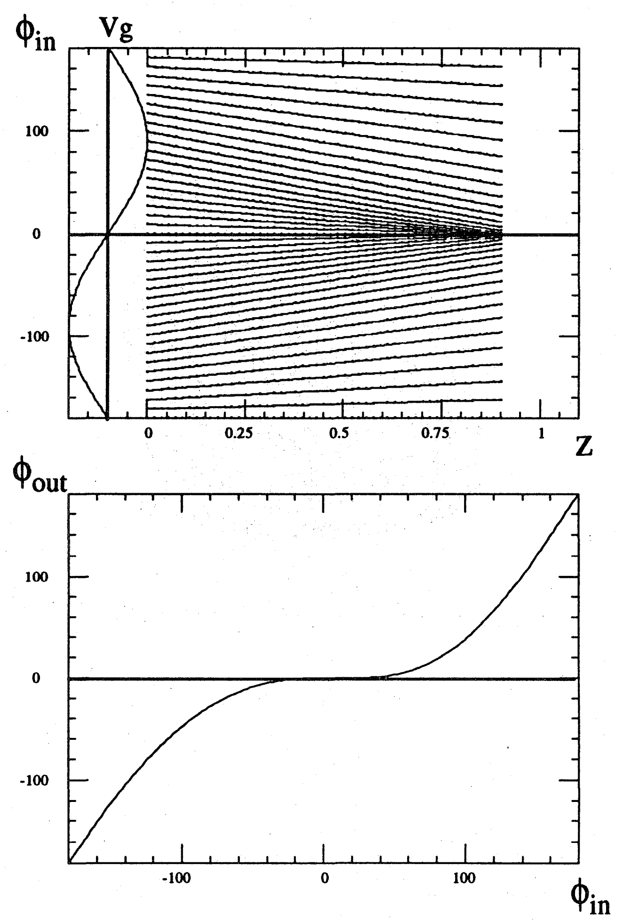


Fig. 1 A normal prebuncher cavity characteristic.

So it will be realized that one prebuncher cavity can be resonated at the fundamental frequency *fo* and the second harmonic frequency *2fo*. Its capture efficient will be 70 %.

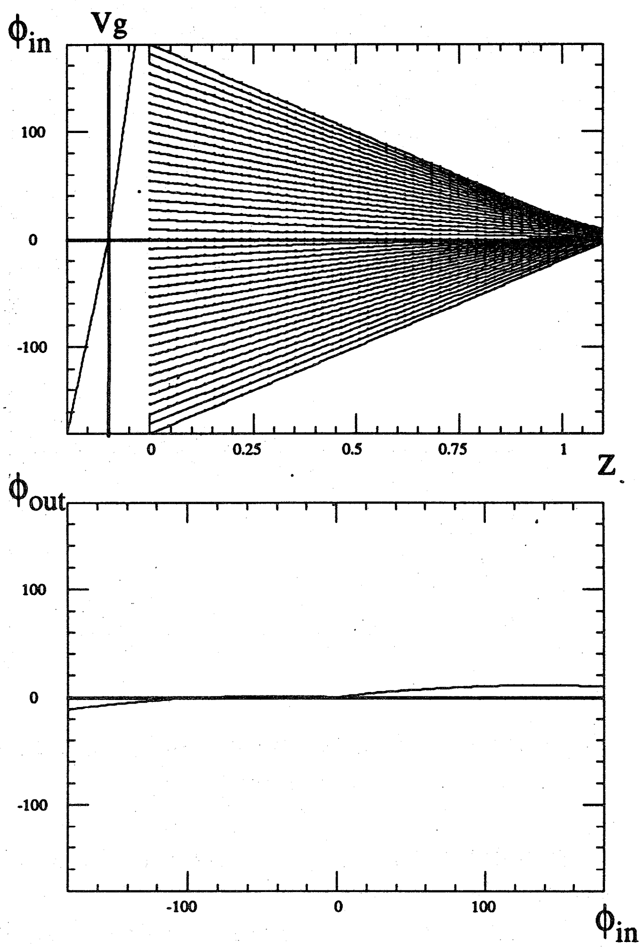


Fig. 2 A ideal prebuncher cavity characteristic.

2. PREBUNCHER CAVITY

Fig.3 shows the fundamental electric field E_{fo} and the second harmonic electric field E_{2fo} and their superposition field E_T. If one chose TM110 mode and TM310 mode to bunch the beam, but in one cavity the frequency of TM310 mode is not equal to two times of the frequency of TM110 mode. The special stub tuners are needed to adjust the frequency of two modes to make TM110 mode resonate at the fundamental frequency *fo* and TM310 mode at the second harmonic frequency *2fo*. Fig.4 and Fig.5 show TM110 mode fields and TM310 mode fields in

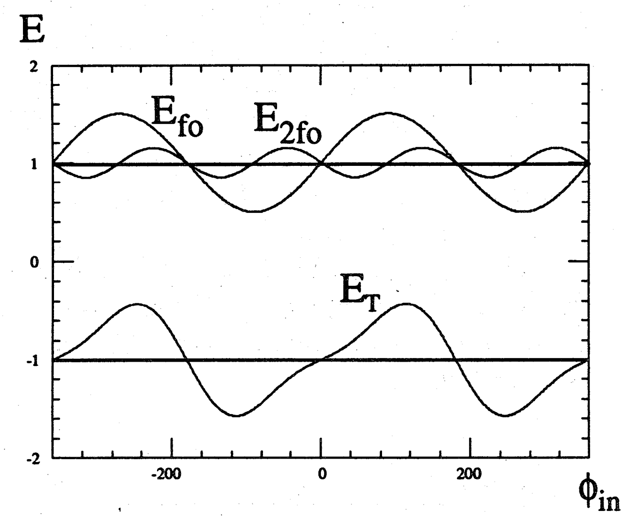
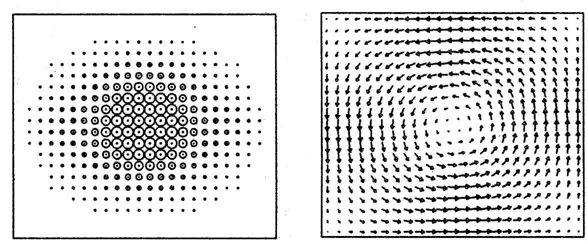
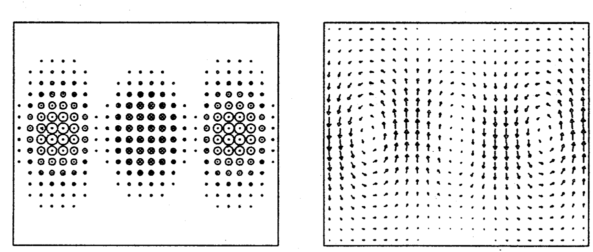


Fig.3 The fundamental electric field, the second harmonic electric field and their superposition field.



(a) electric field (b) magnet field

Fig.4 TM110 mode field in the prebuncher cavity.



(a) electric field (b) magnetic field

Fig.5 TM310 mode fields in the prebuncher cavity.

the prebuncher cavity. Fig.6 shows the structure of the prebuncher cavity. There are four main stub tuners to adjust the frequency in the opposite direction changing for TM_{110} mode and TM_{310} mode respectively, and other four side stub tuners to adjust the frequency in the same direction but different changing ratio.

According to the MAFIA calculation, the cavity size is a=110.0mm, d=129.55mm, h=60.0mm, g=20.0mm, rb=10.0mm, rsm=8.0mm, and hsm=16.75mm.

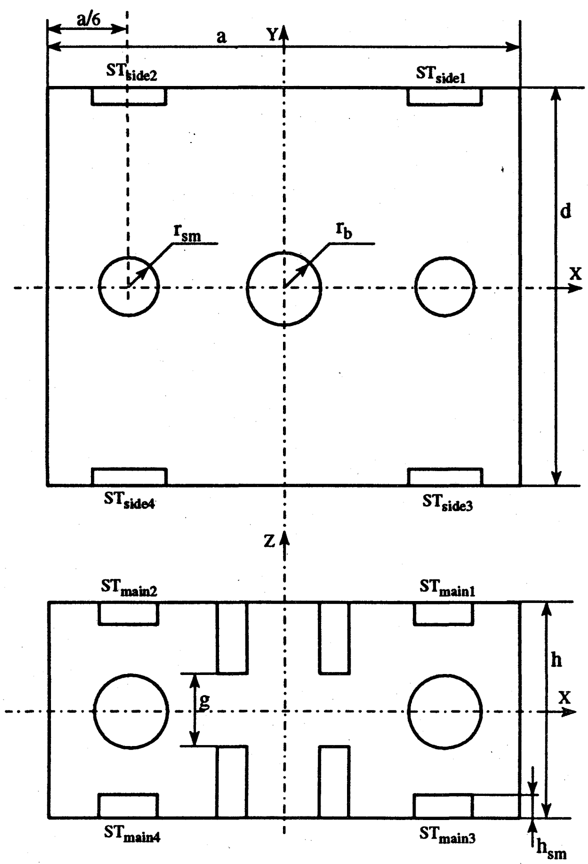


Fig.6 Structure of the prebuncher cavity

3. DYNAMIC CALCULATION

According to the beam longitudinal dynamic calculation, using different ratio of the amplitude of fundamental and second harmonic, and giving some offset angle, the results are shown on Fig.7.

$$Vg=ASin(\omega t)+0.3ASin(2\omega t+\pi-\pi/8).$$

In this case, about 252° beam will bunch in 30° after suitable drift space. Its capture efficient is about 70%.

It is not so difficult to realize according to our chopper system test.

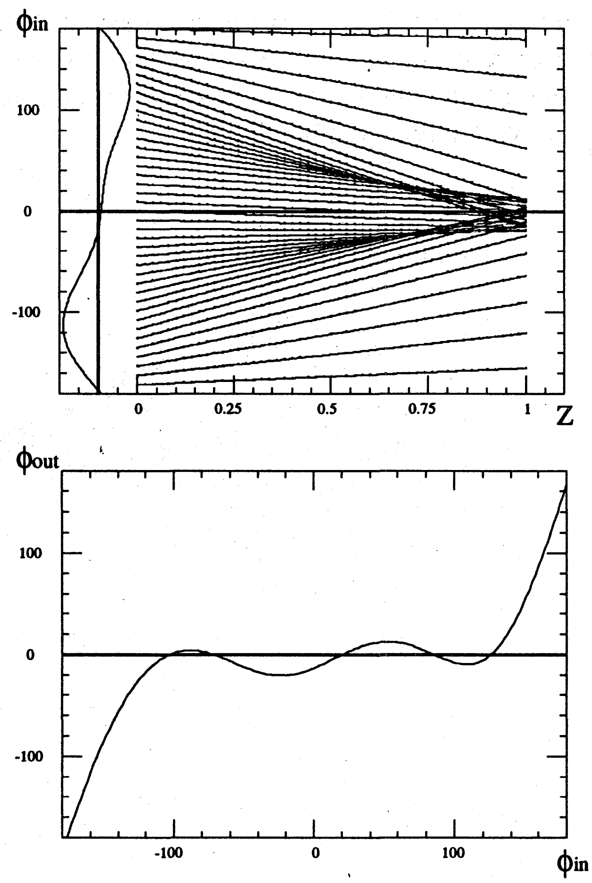


Fig.7 Results of the beam longitudinal dynamic calculation.

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