THE CAPTURE EFFICIENCY OF HIGH FIELD FLUX CONCENTRATOR

R.M. Lapik, P.V. Martyshkin
Budker Institute of Nuclear of Physics
11, Ac. Lavrentiev Ave, Novosibirsk, 630090, Russia

A flux concentrator body cut leads to nonsymmetrical distortion of a transverse magnetic field. The results of positron tracking in distorted magnetic field and positron capture efficiency are presented in this paper for incident electron bunch energy of 6.2 GeV and tungsten positron production target with length of 5 rad.
PACS numbers: 79.20.Mb, 29.17.+w, 29.25.-t

1 INTRODUCTION

At the present time a new generation of height luminosity linear colliders with a high intense bunches is under construction. To provide a high intense positron bunches a flux concentrator with high magnetic field strength up to 10 Tesla or higher is used as a matching device. The matching device like a flux concentrator has a very important geometrical peculiarity - it is a flux concentrator body cut from inside to external surface. This body cut distorts a transverse magnetic field particularly in the plane of cut, thus the geometrical axis of flux concentrator and axis of a transverse magnetic field are not centered.

2 MAGNETIC FIELD

The flux concentrator body cut is a main geometrical peculiarity. The magnetic field strength inside of the gap is the same as the field strength on an axis of flux concentrators or even higher. Operated peculiarity of a flux concentrator is that an Eddy current inducted on a outside surface comes through the gap on an internal conical surface and concentrates at a minimum bore aperture forming the area of strong magnetic field. The Eddy current concentration is observed inside of gap as well as to inside conical surface. The Eddy current, moreover, is directed on a gap edge inside of the conical area from the outcoming gap point to the minimum aperture. By this way a local longitudinal component of Eddy current is appeared on the internal conical surface.

This component of Eddy current forms a strong planar magnetic field directed in the plane of the gap which has the same strength as a transverse field of the flux concentrator for the ideal case (see Fig. 1). The ideal case means not distorted magnetic field due to cut of flux concentrator body. As a result the transverse magnetic field strength on the flux concentrator axis is about 10% - 15% of the longitudinal field strength at this point. Magnetic field strength along the flux concentrator axis and transverse field at different longitudinal position are presented in Fig. 2. Thus geometrical and magnetic axes are displaced. The value of displacement depends on the longitudinal position.

The distortion of longitudinal field is neglecting and its magnetic axis is well centered with the geometrical axis of flux concentrator.

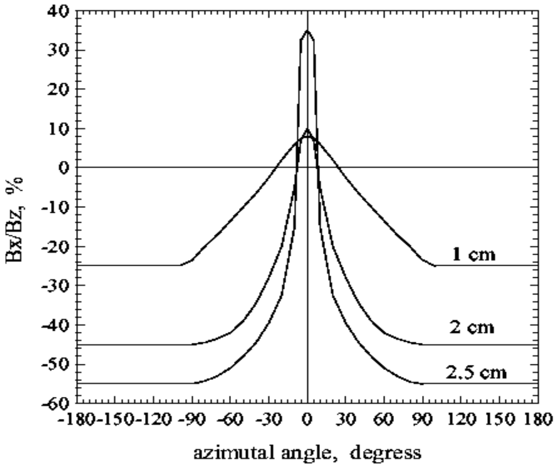

Fig. 1. Azimuthal distribution at point z=3 cm for distance from longitudinal axis 1, 2, 2.5 cm.

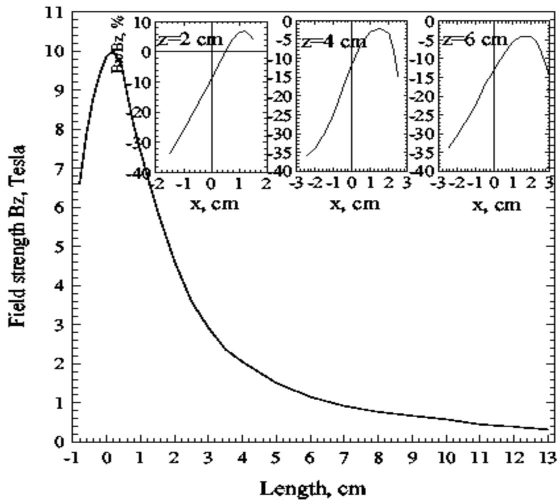

Fig. 2. Longitudinal and transverse field distribution.

3 FC CAPTURE EFFICIENCY

The magnetic and geometrical axes of an ideal matching device are well centered and the strength of transverse field on the axis is equal to zero. When the transverse field is not equal to zero, positrons move in the strong transverse field directed perpendicularly to the main particle motion. As a result, positron bunch obtains an additional angle and is not centered to the accelerator line. This displacement decreases the positron capture efficiency.

In this paper a comparison of positron capture efficiency was done for various strength of FC top magnetic field. The incident electron bunch is centered to geometrical axes of the flux concentrator and accelerator section. The parameters of FC and accelerator are the following: minimum bore diameter of FC is 1 cm, FC length is 16 cm, accelerating ratio is 25 MeV/m, diameter of accelerator section is 2 cm. The solenoid field strength is 0.5 Tesla.

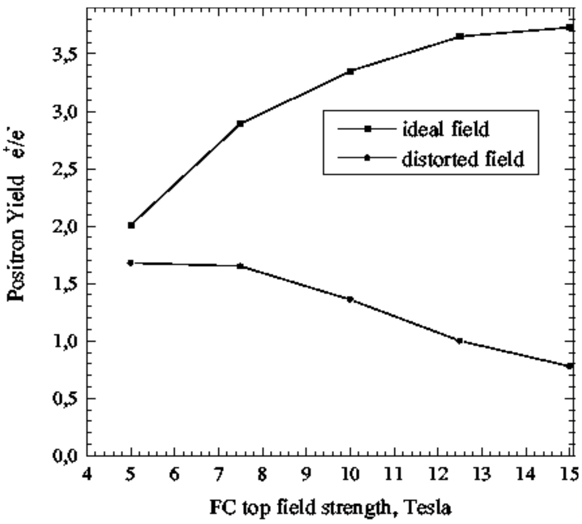

Fig. 3. Positron yield for various flux concentrator top field strengths.

Positron yield was simulated on the basis of GEANT statistics and dynamics in flux concentrator, uniform solenoid field. Energy cut at a positron bunch energy of 250 MeV is ±10 MeV and time cut is ± 30 ps. Positron yield for the ideal matching device as FC and a device with distorted transverse field is shown in Fig. 3. The minimum aperture of the flux concentrator was taken of 1cm in diameter, solenoid field strength 0.5 Tesla. In the second case the positron yield is less in twice or even five times.

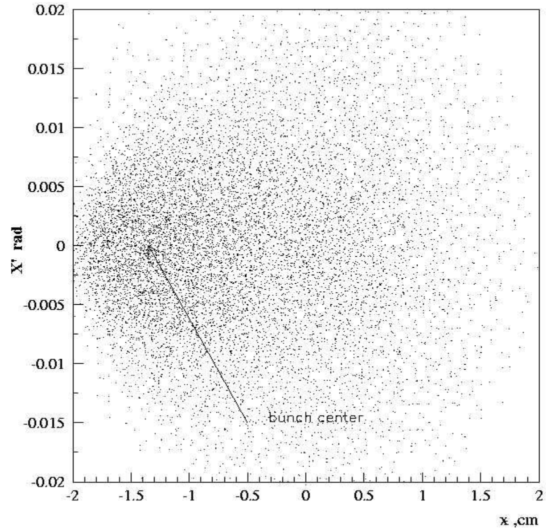

Fig. 4. Positron bunch emittance for the FC field of 15 Tesla.

Positron bunch center after passing the matching device is displaced from the accelerator section center for 1.2–1.4 cm. Positron bunch emittance for FC field of 15 Tesla and particles energy of 100 MeV in shown in Fig. 4.

4 CONCLUSION

As positron yield simulation shows, the capture efficiency of the real matching device is as strong decreased as top field strength is higher. Thus, in order not to lose a particle the transverse magnetic field of flux concentrator should be compensated in addition. Another way is to optimize a correct offset between geometrical axes of FC and accelerator.