Impulse magnet of positron source with adiabatic field decreasing.

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1 INTRODUCTION

Positrons produced by conversion target have a large transfers injection angles and wide energy distribution. To capture positrons a matching device which forms a strong magnetic field is used. This flied may be achieved only by impulse operated device. This device is utilized to form strong magnetic impulse field ($10\ T$) and uses a capacitor bank.

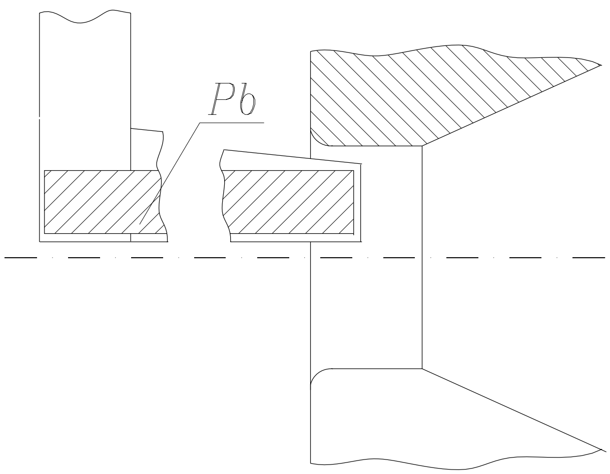

Figure 1: *Sketch of capsule lead liquid target and its location relatively marching device.*

Incident electron bunch with energy $300\ MeV$ and energy spread $\pm 1\%$ is focused by a triplet on conversion target to beam spot size $1\ mm$. Electron bunch length is about $6\ mm$. The total target yield for positron after tungsten conversion target and the one radial angle and energy distributions had been calculated using the electromagnetic shower simulation provided by the GEANT code[1]. The total positron yield defined as the number of positron generated per one incident electron from such a target is about 0.8.

To avoid a thermal heating damage of conversion target is usually utilized a rotated tungsten target with water cooling [2]. To technical unloading of conversion system by a different elements was decided to use a lead liquid target of capsule type (fig.1). The melting of lead is a result of incident electron bunch energy deposition in target material. Application of this target allows to locate it into top magnetic field and doesn't require additional target cooling.

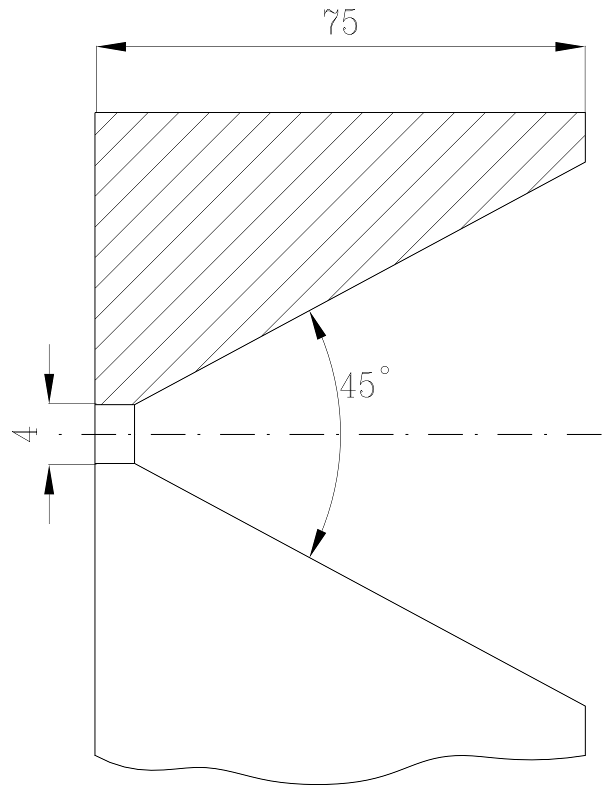

Figure 2: *Cross section of pulsed magnet prototype .*

2 IMPULSE MAGNET PROTOTYPE

Positron beam injected from conversion target occupies a large space volume and is wide distributed in energy (from several MeV to several dozen MeV). Impulse magnet forms adiabatically decreasing longitudinal magnetic field with required shape. Magnet is located after conversion target and acts as short focal length lens.

To measure a magnetic field of matching device the prototype has been fabricated as a single turn solenoid with a radial cut to center of conical hole. A cross section of pulsed magnet prototype is schematically shown in fig.2. The copper body of prototype is $75\ mm$ along and internal cone angle is $45°$. Minimal aperture d of magnet prototype is $4\ mm$.

The magnet prototype is powered by a sinusoidal shaped current pulse of $75\ kA$ to produce a peak magnetic field of 10 Tesla at a conversion target. The longitudinal mag-

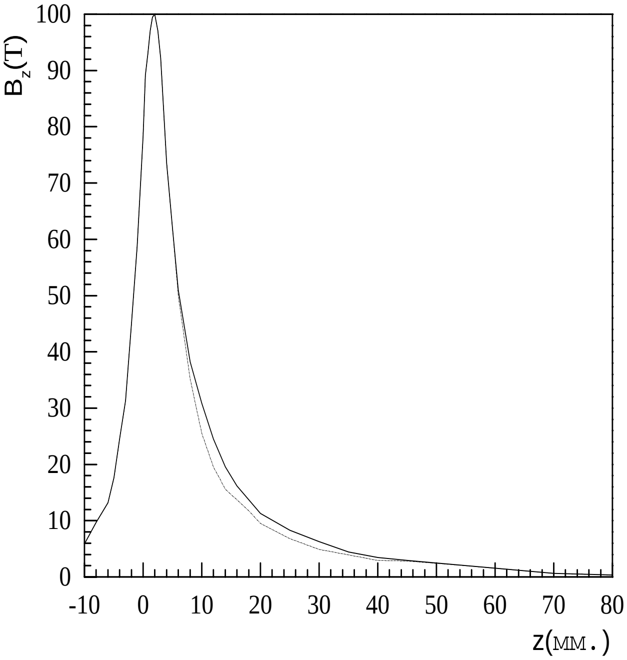

Figure 3: *Magnetic field profile along longitudinal exes of prototype. Dashed line – 4 мм solid line 5 мм.*

netic field along axis of prototype is presented in fig.3 by a dashed line. Energy deposition of magnetic field inside conical hole of device is about $10\ J$.

After several tests of a previous magnet prototype the minimal aperture d was increased up to $5\ mm$ and the tests of a second prototype were repeated. The longitudinal field of a second magnet prototype is slight different (fig.3 solid line). To obtain a peak magnetic field strength of 10 Tesla a $100\ kA$ current pulse was required that is increased 30% against of a first pulsed magnet prototype test. Magnetic field strength at rear plane of impulse magnet decreases to 0.1 Tesla for both magnet prototypes.

A current pulse of time length $20\ \mu sec$ had been used for both test series of magnet prototype. Magnet had been placed on an air and its external body surface was cooled by a water flow. Temperature of magnet body was increased to $40 \div 50°C$ in $2 \div 3$ hours of test with repetition rate $50\ pps$. Energy deposition of capacitor bank is triple large the energy deposition of magnetic field inside conical hole.

3 NUMERICAL SIMULATION

For numerical simulation of magnet prototype a special code based on final differences method had been written. This code allows to simulate magnetic impulse field of any magnet geometry with axial symmetry. Conversion target and accelerating structure location is also available to include into consideration.

Close located accelerating structure at rear plane of impulse magnet decreases strength of magnetic field. Fig.4 shows a behavior of magnetic field strength in front plane of accelerating structure for different cases of structure and impulse magnet position. Minimum aperture of impulse magnet is $5\ mm$. Distance between structure and impulse magnet was chosen to be $10, 30, 50\ mm$. Location of magnet rear plane and accelerating structure are marked in fig.4. As one can see, magnetic field strength is decreased fast almost to zero value in front plane of accelerating structure.

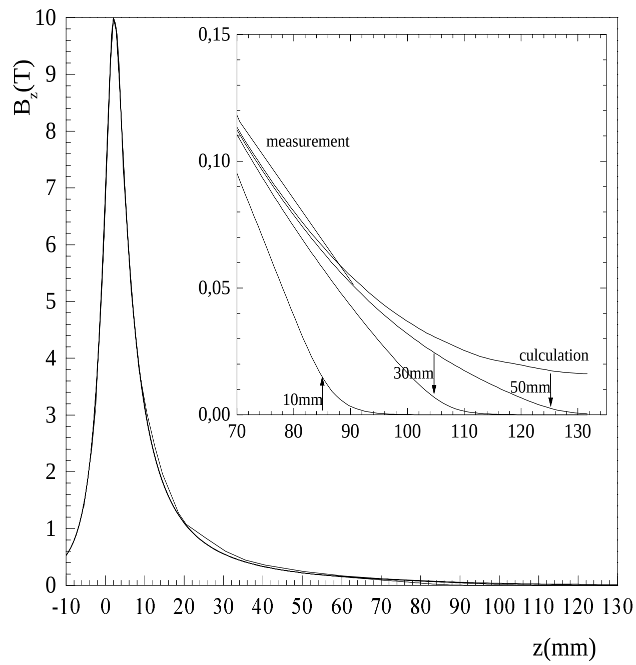

Figure 4: *Numerical simulation of impulse magnet with closed location of accelerating structure.*

4 CONCLUSIONS

The tests of both impulse magnet prototypes with conversion target demonstrated a technical realizations opportunity of this positron system design. It had been erident, during the operation time, that a $15\ Tesla$ magnetic field strength is quite technically reliable for repetition rate $50\ pps$.

5 REFERENCES

[1] GEANT—Detector Description and simulation Tool. CERN, Geneva 1993.

[2] *Stan Encklud* Positrons for linear colliders. SLAC–PUB–4484, November 1987(M).