THE NONSYMMETRICAL VARIANT OF THE NONFERROMAGNETIC EXTRACTION KICKER MAGNET OF THE NICA BOOSTER

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Abstract

Development and creation of the NICA acceleration complex are continued at JINR (Dubna). One of the main facilities of the complex is the Booster in which preliminary acceleration and cooling of an ion beam is performed. Further acceleration is fulfilled in the circular accelerator NUCLOTRON. The beam transfer from the Booster into the NUCLOTRON is provided by means of the fast extraction system and one of its central elements is the kicker magnet. For the beam deflecting into the extraction septum-magnet it is supposed to use the nonferrous kicker magnet consisting of two couples of conductors. Recent changes made in configuration of the Booster extraction section demand decrease of the kicker magnet length that leads to change of the beam extraction scheme. This report is devoted to the choice of the alternative design of the magnet (the nonsymmetrical variant).

INTRODUCTION

Within the NICA [1] project creation and development not only traditional, but also new transition systems of a beam is supposed. In article [2] the kicker magnet consisting of two couples of conductors in which the ferromagnetic yoke is not used is offered.

According to [3] extraction of ions from the Booster it is supposed to carry out in 2 stages. At the first stage the circulating beam is brought to a septum-magnet knife by means of a bump subsystem of a closed orbit. At the second stage an extraction of ions from the Booster is carried out actually. The kicker magnet represents two couples of conductors established inside vacuum box parallel to an axis of driving of a beam. Maximal magnetic field – 0.13 T, the corresponding current in conductors of a magnet – 15 kA. Inhomogeneity of a magnetic field in the area occupied by a bunch does not exceed ±1 %.

THE EXPECTED BEAM PARAMETERS

Calculated parameters of a beam in the location of a kicker magnet on energy of injection and the maximal energy are given in Table 1. The option of an extraction called in Table 1 "initial" was assumed at the time of the publication of article [2].

Table 1: Beam Parameters

	injection	extraction options	
		initial [2]	new [3]
ε_x, π mm · mrad	150	15	3
ε_y, π mm · mrad	10	2	1.5
Max β_x, mm / mrad	12	12	12
Max β_y, mm / mrad	12	12	6.5
D_x, m	1	1	0.1
$\Delta p/p$	$\pm 5 \cdot 10^{-4}$	$\pm 3.6 \cdot 10^{-3}$	$\pm 5 \cdot 10^{-4}$
Max A_x, mm	43	17	6
Max A_y, mm	11	5	3.3

NONSYMMETRICAL VARIANT OF THE KICKER MAGNET

New parameters of a bunch at the maximal energy, in particular, considerably smaller cross sectional dimensions, and also pulse character of a magnetic field, give the possibility to offer a kicker magnet consisting of one couple of conductors and the copper screen replacing the second couple of conductors with an opposite direction of current (Fig. 1).

As a current pulse length in a kicker magnet is about one microsecond, the strong skin effect takes place, and numerical simulation of magnetic fields can be carried out in the following approach. The magnetic field in conductors is absent, current is distributed on a surface of conductors. In model of an infinitely long magnet a current is directed along a longitudinal axis. Respectively the vector potential of a magnetic field has only a longitudinal component. In such approaching the problem of calculation of a pulse magnetic field is equivalent to an electrostatic task. It allows to carry out calculations for the choice of a configuration of couple of conductors and the screen by means of a POISSON [4] package in twodimensional model, trying to obtain the required distribution of a horizontal component of an electric field.

In calculations the following main variants of a magnet were considered: variant with the flat screen and variants with screens arched in the vertical plane with various radii of curvature. For expansion of area of uniformity of the field the distances between main elements were increased from 40 to 50 mm.

In Fig. 2 corresponding distributions of the field are shown.

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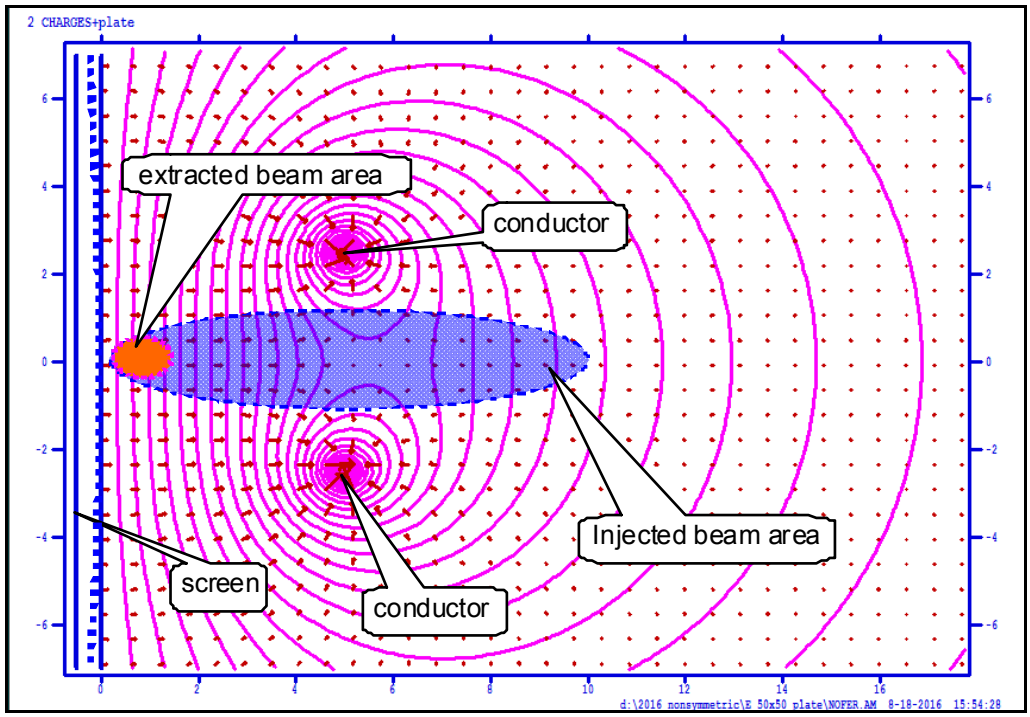
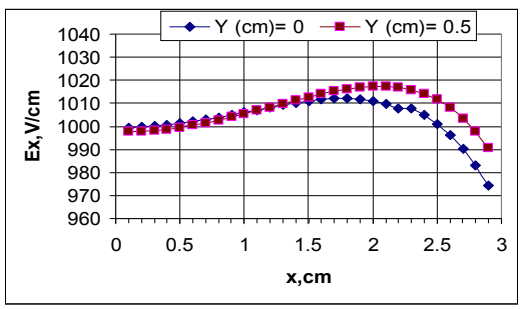
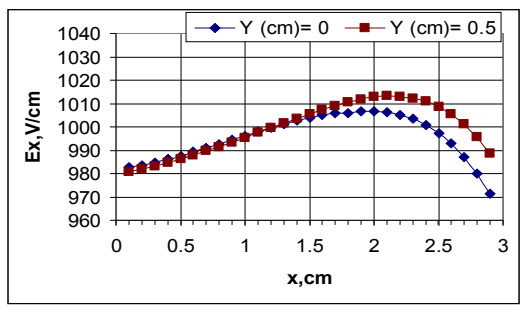


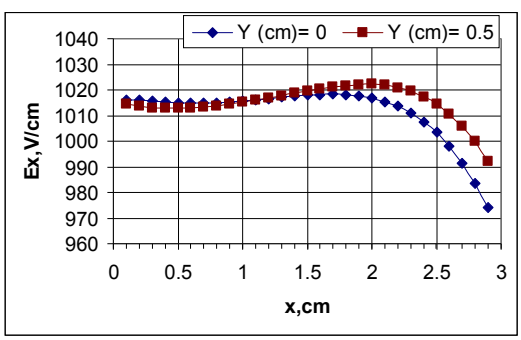
Figure 1: Arrangement of elements of a kicker magnet.



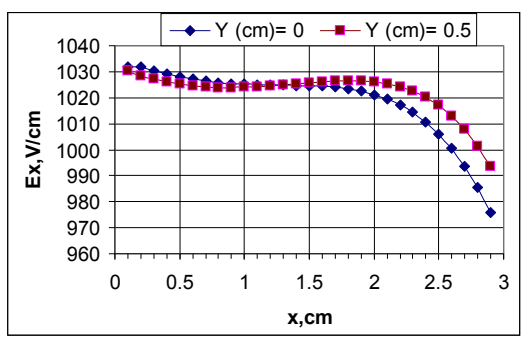
Flat screen: ±1.0 %



Concave screen: R=1000 mm, ±1.6 %



Convex screen: R=1000 mm, ±0.9 %



Convex screen: R=500 mm, ±0.5 %

Figure 2: Distributions of the field between the screen and conductors, inhomogeneity of the field in the area x = 0...20 mm is specified as a percentage.

CONCLUSION

The nonsymmetrical variant of a kicker magnet consisting of one couple of conductors and the copper screen is offered. The distance between axes of conductors is 50 mm. The copper screen is installed in 50 mm from the plane of couple of conductors. Screen parameters: thickness is 3 mm, width is about 180 mm. Such kicker magnet can provide uniformity of the field in the extraction region not worse than 0.5 % at the suitable

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choice of radius of curvature. The required current in conductors of a magnet is about 20 kA.

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