BEAM DYNAMICS IN THE ACCELERATOR COMPLEX SALO

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The length of the electron trajectories in the recirculator SALO with taking into account the length of the channel output can exceed 200 m. The electron beam passes through the magnetic structure only once. The motion of electrons is under influence of more than 30 dipole magnets and more than 40 quadrupole magnets. Due to the specifics of the injection system and motion separation by different arcs, the beam moves in inhomogeneous fields that should affect the beam dynamics. The paper presents the results of a detailed study on the beam transverse motion along the electron trajectory.

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INTRODUCTION

The nonlinear components of magnetic field dipoles exert significant influence on the characteristics of a beam as early as it passes through the single magnet [1]. The magnetic recirculator SALO, being developed in the NSC KIPT, comprises more than 30 dipole magnets and more than 40 quadrupole lenses [2]. The nonlinear field components of these devices can affect the beam motion along the electron trajectory [2 - 4]. A detailed study of the beam motion through the channels of beam extraction from the recirculator [4] has shown that the octupole components of quadrupole lenses have no significant influence on the beam distribution perpendicularly to the particle motion, and the sextupole components of dipole magnets, used in the transport channels exert influence on the particle motion in the channels.

Characteristics of the transverse particle motion in the recirculator SALO were thoroughly studied only in the points at the input into the channels for beam transport to the physical devices [2]. The purpose of the present paper is to investigate in more details the particle motion along the electron trajectory in the recirculator.

MODELING OF ELECTRON MOTION IN THE INJECTION TRACK AND IN THE FIRST RING

The magnetooptical structure of the recirculator SALO is presented in Fig. 1. The structure was formed as a result of optimizing the position and operating conditions for the magnet elements of the recirculator magnetooptical system in order to decrease the beam sizes in the points of output from the recirculator and input into the transport channels.

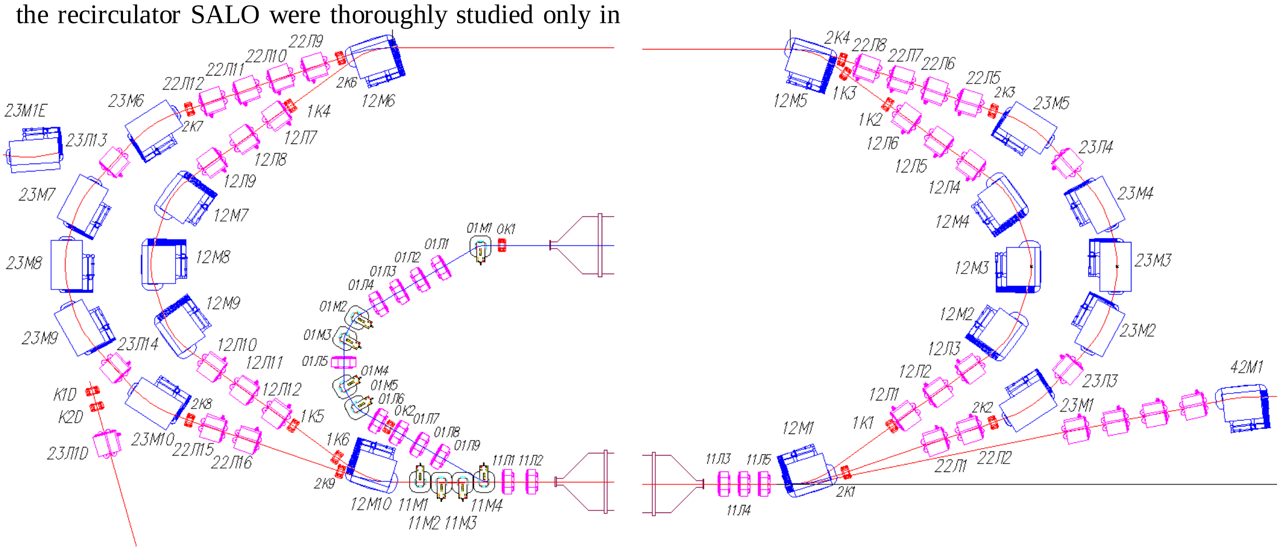


Fig. 1. Magnetooptical system of the recirculator

In [2] only the amplitude functions of focusing in the recirculator are presented to give a notion of the beam size without detailed description of the behavior of electron motion in the cross-section along the trajectory. The detailed information can be obtained by particle tracking through the system with the help of MAD X program [5]. The paper presents the results of 3500 electrons passing through the structure.

In Fig. 2 shown are the beam cross-sections along the injection channel for the maximum injection energy equal to 20 Mev. Sizes and emittance of the injection beam correspond to the values adopted in [2 - 4].

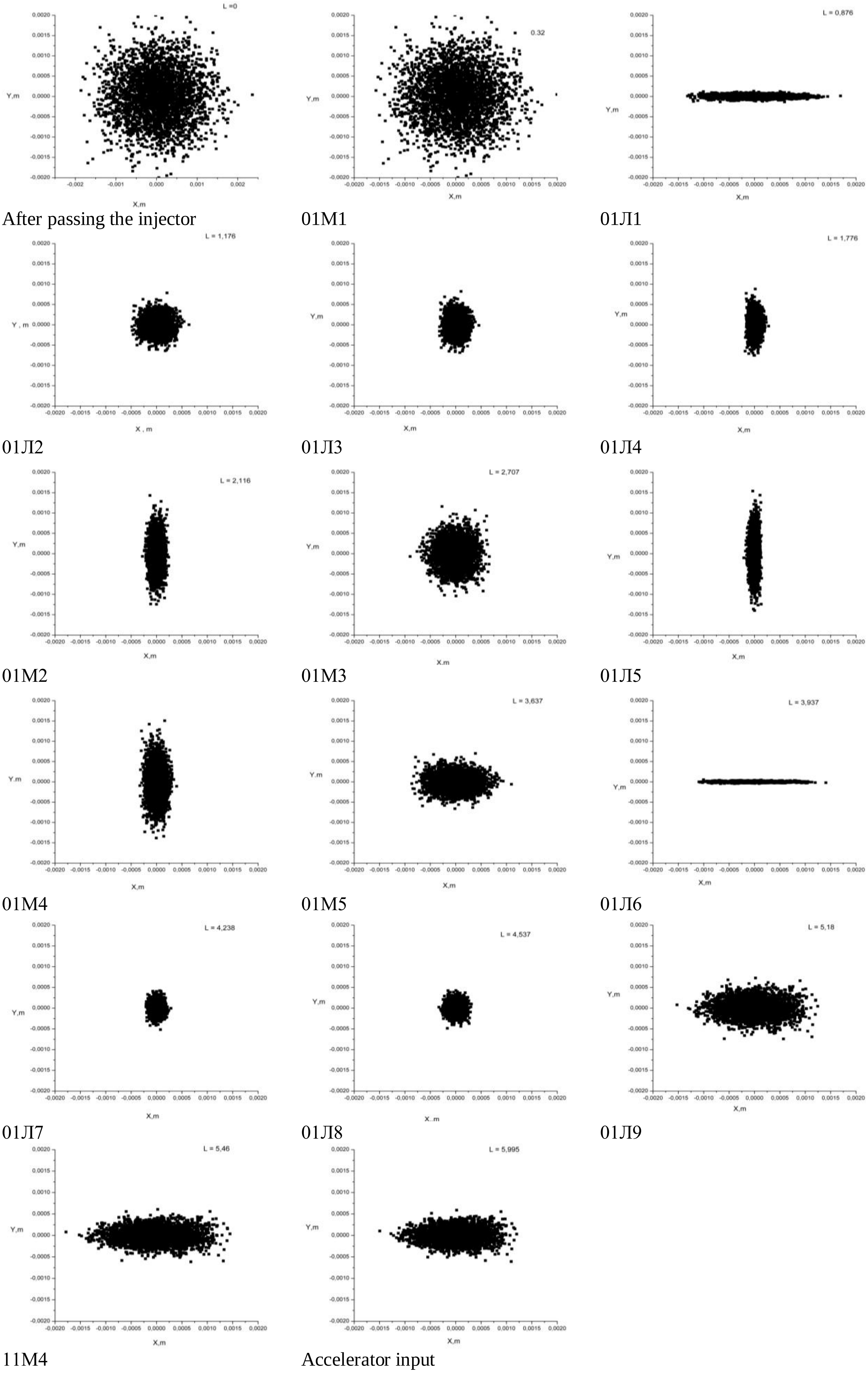
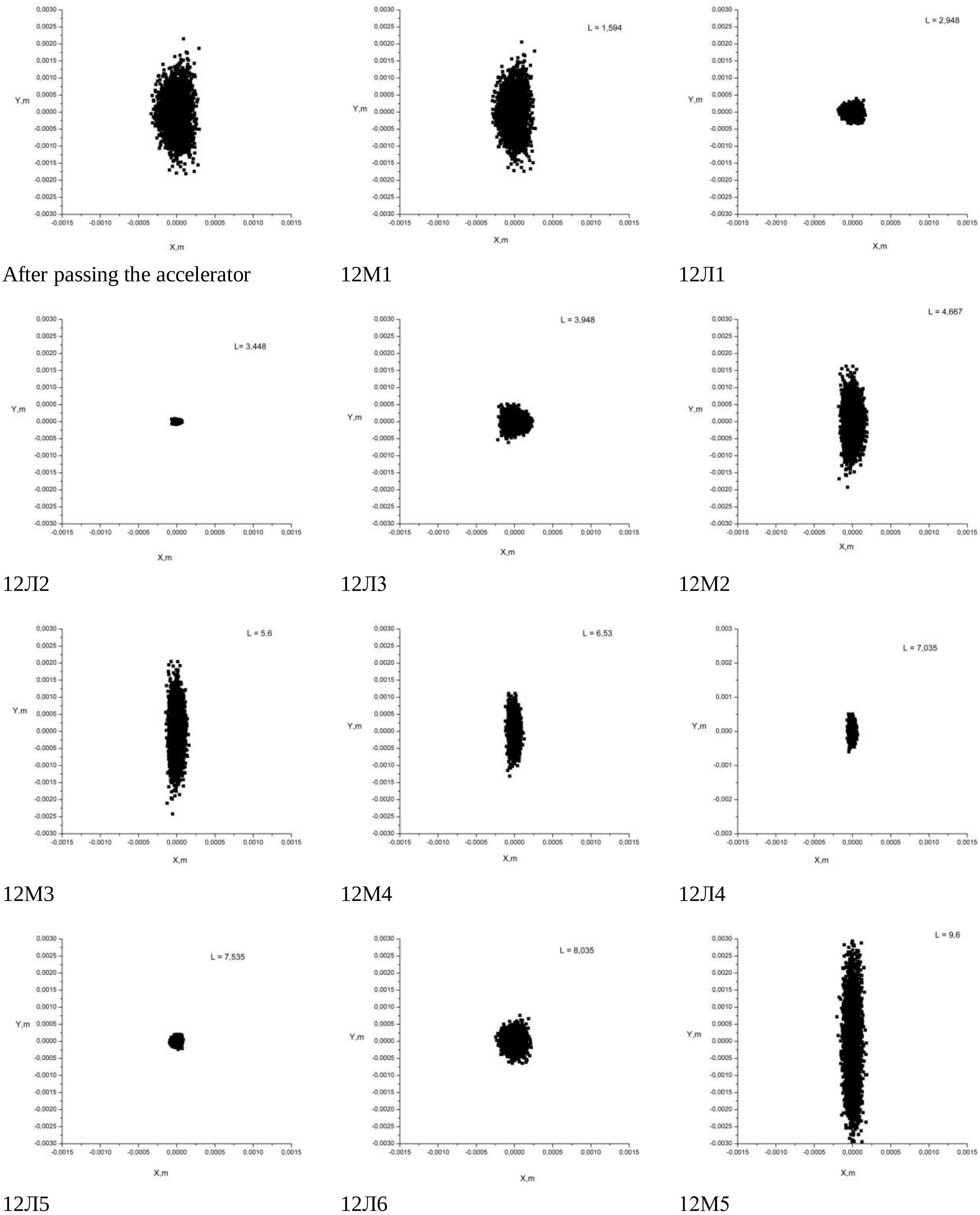


Fig. 2. Beam cross-section along the injection channel

The figure shows the beam cross-sections at the output from the magnetic elements along the electron motion. It is seen that after passing the first dipoles in the transport system the electron density symmetry, relatively to the vertical beam axis, is changing with the effect increasing towards the tract end. When modeling the particle motion we have taken into account the nonlinear components of dipole and quadrupole magnets as in [2 - 4]. Fig. 3 presents the beam cross-sections along the first arc of the first rotation in the recirculator when the electron energy has been increased to 256 MeV after passing the accelerating structure. The change in both the vertical beam size and the horizontal beam size, as well as, in the beam shape is observed.



After passing the accelerator; 12M1; 12Л1; 12Л2; 12Л3; 12M2; 12M3; 12M4; 12Л4; 12Л5; 12Л6; 12M5

Fig. 3. Beam cross-section in the first semiarc of the first rotation

One can see from the figure that after passing the long rectilinear space, not comprising the focusing magnetic elements, the beam cross-section shape is being continued with beam size increasing. The results of particle motion simulation on this part of the trajectory are given in Fig. 4.

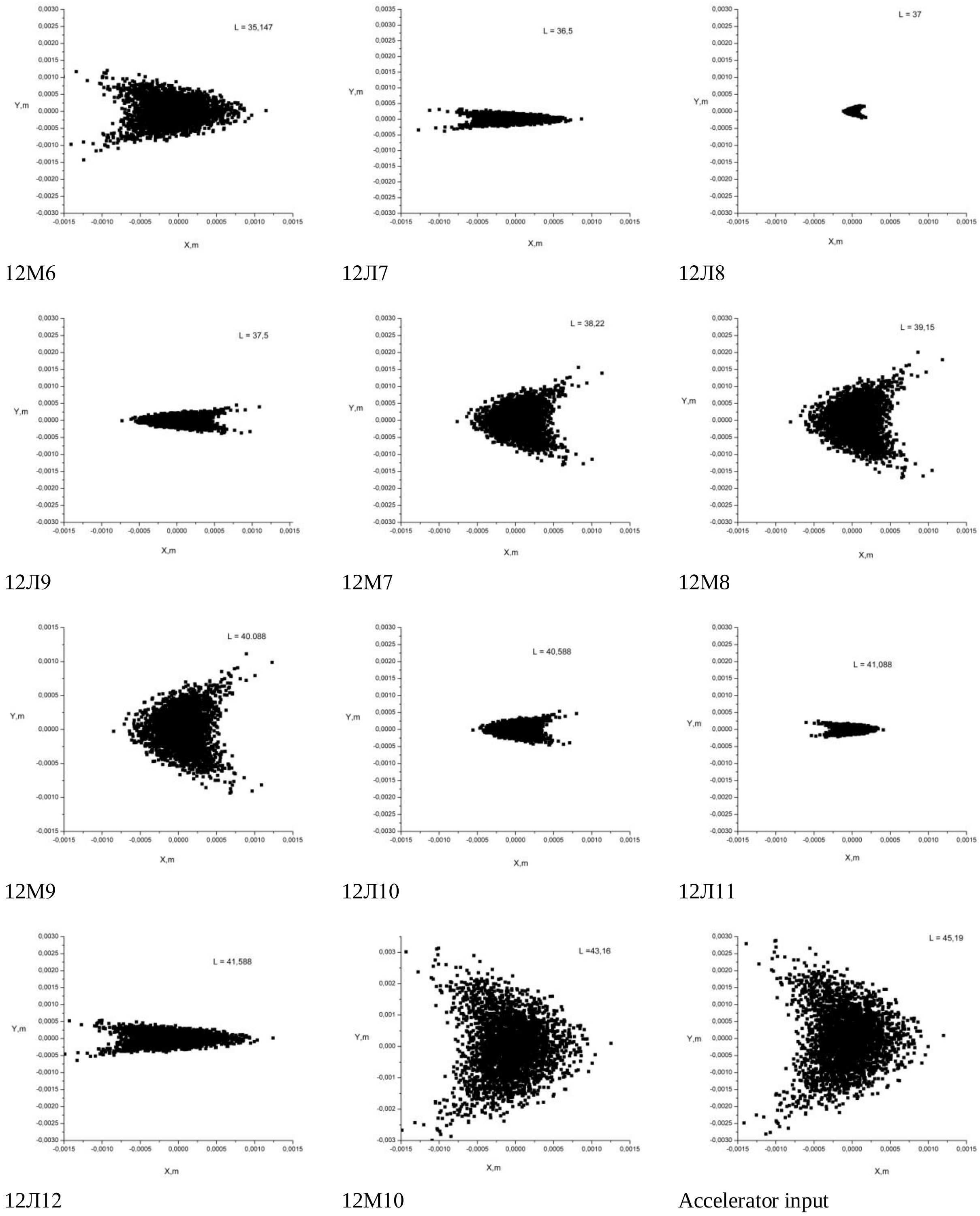


Fig. 4. Beam cross-section in the second arc of the first rotation

After passing for the second time the accelerating structures, the electron energy reaches the values of about 500 MeV. It is shown in [2] that in the case of beam motion in the second ring of recirculation, in the points of input and output from the arcs, the sextupole component, practically, has no influence on the beam cross-section. The beam sizes in the radial and vertical directions are determined by the magnetooptical structure of the ring.

On the channels of beam extraction from the recirculator the influence of the sextupole components of dipole magnets is evident enough that is connected, first of all, with appreciable differences in the structures of the ring and channels [4, 6].

CONCLUSIONS

The results of the present investigations have shown that the use of the MAD X program for developing the structure under consideration permits to obtain a more detailed information about the electron motion in the recirculator that, in its turn, provides a fine adjustment for beam parameters in the channel input points The additional information is useful also for the choice of a design and parameters of dipole and quadrupole magnets for the structure.

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ДИНАМИКА ПУЧКА В УСКОРИТЕЛЬНОМ КОМПЛЕКСЕ SALO

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Длина траектории электронов в рециркуляторе SALO с учётом длины каналов вывода может превышать 200 м. Пучок электронов проходит магнитную структуру только один раз. При этом движении электроны испытывают влияние более 30 дипольных и более 40 квадрупольных магнитов. В силу особенностей системы инжекции и разделения движения по разным дугам пучок движется в неоднородных полях, что должно сказываться на динамике пучка. Приводятся результаты детального исследования поперечного движения пучка вдоль траектории.

ДИНАМІКА ПУЧКА В ПРИСКОРЮВАЛЬНОМУ КОМПЛЕКСІ SALO

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Довжина траєкторії електронів у рециркуляторі SALO з урахуванням довжини каналів виводу може перевищувати 200 м. Пучок електронів проходить магнітну структуру тільки один раз. При цьому русі електрони відчувають вплив більш ніж 30 дипольних і 40 квадрупольних магнітів. У силу особливостей системи інжекції і розподілу руху по різним дугам пучок рухається в неоднорідних полях, що повинно позначатися на динаміку пучка. Приводяться результати детального дослідження поперечного руху пучка уздовж траєкторії електронів.