Formation and Transport of Intensive Sheet Electron Beam for High Power Microwave Devices

P. Akimov[1], A. Nikitin[1], V. Chudin[1], A. Gavrilin[1], V. Syrovoy[2]
[1] Federal State Unitary Enterprise "Scientific & Research Corp. "Toriy"
52 Obrucheva str., Moscow, Russian Federation,
[2] All-Russian Electrotechnical Institute, Krasnokazarmennaya ul. 12, Moscow
E-mail: torlab107@mail.ru

***Abstract*—Mathematic theory and results calculation are presented for intensive electron sheet beam with elliptical and "near rectangular" cross section.**

I. INTRODUCTION

DURING last decade great numbers of papers were published on design of various microwave devices with high power sheet beams. The information about electron optical systems is often limited by illustrations which are result of 3D trajectory analysis codes using. In these investigations linear compression L of the beam may be so high as $L \geq 30$, so such calculations must have the accuracy of about 0.3% to guarantee the correct result for linear sizes 1/L . We don't know the methodic investigations of this problem: the analysis must be founded on testing calculations with using of full set of 2D and 3D exact solutions of beam equations. The problems of adequate models of near cathode region in ρ- or T-mode are actual up to date.

II. RESULTS

In this paper we present two mathematical models of electron optical system described by ordinary differential equations. The former is based on 3D-theory of relativistic beams with elliptical flow tubes [1]. The initial information includes potential and magnetic field distributions on beam axis and postulated change law for one of half-axis of cross-section. The variation of other half-axis satisfies to ordinary differential equation of second order. The vicinity of singular emitting surface in ρ- and T-modes is described by corresponding asymptotic. The forming electrodes are defined by algebraic correlations which may be corrected in near-cathode region due to the exact solution for cylindrical beam with elliptic cross-section. The latter model is specialization of geometrized theory of relativistic electron beam [1]. This theory is formulated in a priori non-known coordinate system associated with flow tubes. The initial beam equation in partial derivatives and Euclidean conditions for metric tensor elements are transformed to one correlation on flow tube with longitudinal derivatives only and system of evolutionary equations for transversal flow parameter derivatives. Such representation allows us to construct the higher approximations for non-paraxial flows. The algorithms of formation for "near rectangular" beam cross-section are discussed. The transport problem has two variants: technological form of tunnel (rectangular cross-section) or preservation of initial elliptical beam configuration. In former case the solution is achieved by numerical methods only, in latter such methods are not needed. For beam with constant elliptic cross-section and non-homogeneous distribution of space-charge the tunnel form is described by elementary functions and it isn't elliptical, of course.

The configurations of electron beam, forming electrodes and transportare tunnel are calculated. In figures 1-3 are represented the results of calculated

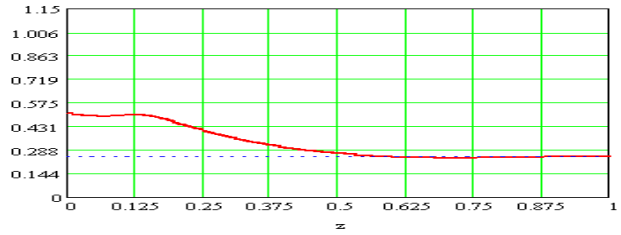

Fig.1. Value of compression elliptic cross-section of the beam along half axis b

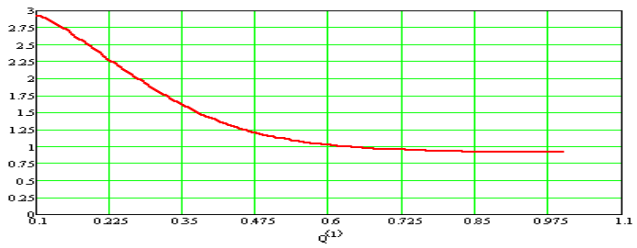

Fig.2. Value of compression elliptic cross-section of the beam along half axis a

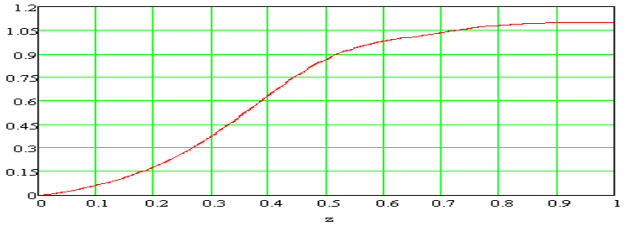

Fig.3. The potential on axial trajectory of electron beam

III. SUMMARY

The offered calculation method of the shaping systems allows to construct the guns and systems of the transportation of elliptical and sheet electron beams. The method can be used also in the event of external focusing magnetic fields presence.

REFERENCES

[1]. V.A. Syrovoy Theory of intense beams of charged particles. ELSEVIER,2011.