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Electron beam self-focusing control in breakdown plasma by external magnetic field

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Electron beams with high current density present a great interest for industrial and medical application because of its capacity to transport stored energy through rather long distance to the target objects without any noticeable losses. Besides, it is possible to control the beam parameters by means of external transporting conditions.

In this work, the theoretical and experimental results due to additional external systems transporting investigation and focusing of electron beam propagation in the drift tube filled with plasma discharged at low pressure argon $10^{-2} \sim 10^{-4}$ Torr were determined.

The electrons movement equations in general case of nonuniform external field were analytically and numerically solved. It was obtained that the nonuniform of external magnetic field have noticeable role in transporting of electron beam.

The experiments were conducted on several machines to determine the configuration influence of the magnetic field on compression (defocusing) of the beam. The experiments were realized also with application of two or three solenoids. The location of solenoids had been calculated theoretically. Experiments show possibility of compression of the beam, and increase in stability of the distribution of energy density on the irradiation area.

The focusing of electron beam with initial angle speed spread $tg\theta = v_{\perp}/ v_z = 0.26$ ($\theta \sim 16^{o}$) is shown in Fig. 1.

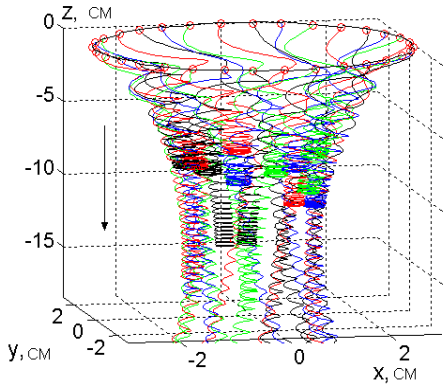

Fig.1. Configuration of the electron beam.

The radius of beam transporting envelope and longitudinal velocity of electrons essentially depends on the level of magnetic field gradient and the distance ratio between focuses and beam parameters. Changing of magnetic field can be governed by the energy density transferred to the beam collector.