EFFECTS OF PROPAGATION FOR HIGH POWER CW ELECTRON BEAM IN AIR

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Abstract

The question of effects at during of propagation for high power scanning electron beam in air presents the scientific and applied interest. The high power (80 kW) CW electron accelerator Rhodotron with kinetic energy of electrons 5 MeV was used in the experiments. The experimental results for propagation of scanning electron beams in air are presented and discussed. The physical model for explanation of these results is suggested.

INTRODUCTION

The propagation for scanning relativistic electron beam in air observes effects of variation of current density and cross section of beam, erosion of beam front [1,2,3]. These effects can not be explain by standard physical models and it presents the motivation of this research.

The results of experimental research for propagation of high power parallel scanning relativistic CW electron beam in air are presented in this report.

EXPERIMENT

The CW electron accelerator "Rhodotron" from IBA [4] was used in the experiments with next main parameters:

- kinetic energy of electrons………..….. 5 MeV;
- power of electron beam (max) ..……... 80 kW;
- diameter of beam after foil window… … 8 cm;
- repetition of scanning beam…………..60-100 Hz;
- frequency of CW mode…………………108 MHz.

The scanning mode for electron beam is given on Figure 1.

The current transformers (Rogowski Coils) and Faraday Cups with current shunts were used for measurements of beam current.

The sensor for measurements of conductivity of air plasma is presented on Fig. 2. The principle of work for this sensor is next. The scanning electron beam across thin Ti foil and absorbed in the these foil with small factor. The capacitor C charges as a results of absorption of electron beam. When electron beam moves to other side from sensor, the capacitor C discharge on the resistor R. The air plasma forms by scanning electron beam is switch for this C-R circuit.

The standard Cellulose TriAcetate (CTA) films dosimeters (FTR-125) were used for measurements of dose distribution in cross section. The CTA films with width 100 cm were fixed with step 20 cm after foil window of electron accelerator. The distance between first CTA film and foil window of accelerator was 10 cm.

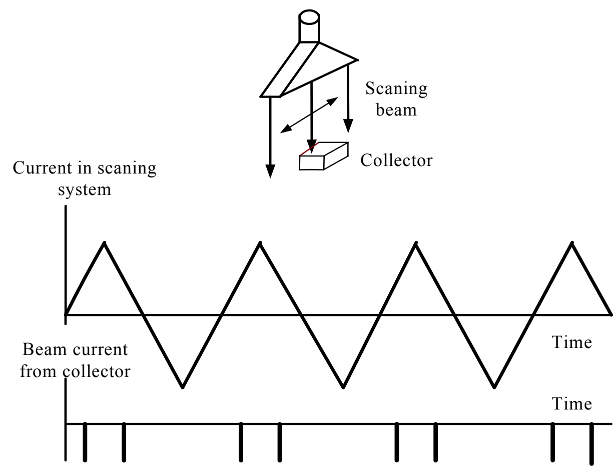

Figure 1: Scanning mode of beam

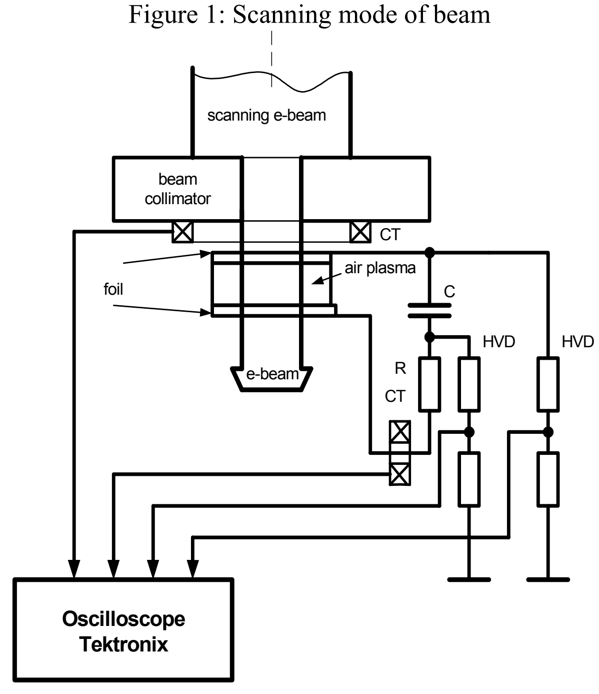

Figure2: Measurements of plasma conductivity.

EXPERIMANTAL RESULTS

The cross section distributions of absorbed doses in air are shown on Figure 3. This distribution has place for electron beam in cross section.

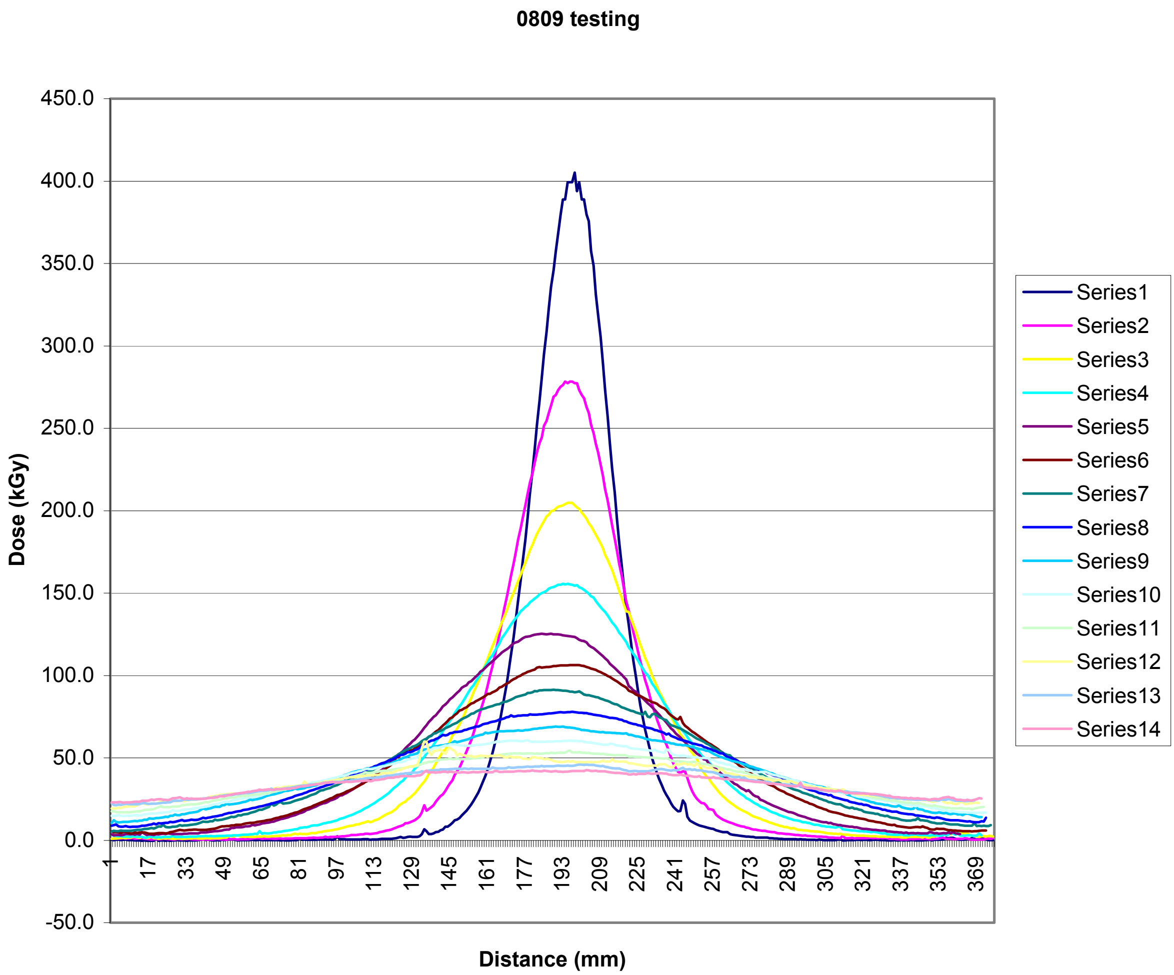

Figure 3: The dose distribution in CTA film dosimeters in cross section of electron beam in air.

The measurements of conductivity of air plasma are given high resistance air plasma. For current 1 mA the resistance between 1x1 cmxcm Ti foil and gap 1 cm is 280 kOhm and resistance is 110 Kohn for beam current 16 mA.

DISCUSSION

At during of the propagation of CW relativistic electron beam in air we can consider the next main physical processes:

* the ionization of air molecules by electrons of beam and forming air plasma;
* the heating of air and air plasma;
* the chemical reactions with produce of ozone.

The mechanism of forming of air plasma can be explain using of perpendicular component of beam velocity for ionisation of air molecules by electron beam. In this case we have low velocity and the cross section of ionisation by electrons increases. As a result of it, we form high resistance air plasma. The scattering of primary electron beam on the components of this air plasma leads to increasing of beam dimensions in cross section. The effects of neutralization of space charge of electron can be neglected for small value of beam current (the max current is 16 mA) .

CONCLUSION

As results of conducted research we can make next conclusions:

1. The beam current density is decreasing in cross section along propagation of electron beam in air.
2. The air plasma forming by scanning electron beam has high resistance.

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