Cathode Edge Effect and Divergence of Emitted Electron Beams in Vircators

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Abstract**—**This paper analyses the beam imprint and beam microbeams of high explosive emission cathodes that are used in virtual cathode oscillators (Vircators). The results show the influence of the edge effect and how acquiring the microbeams' imprint can estimate the transverse momenta spread of the cathode beam.

Keywords-Vircators; Beam imprints; Explosive emission cathodes; Edge effect.

I. INTRODUCTION

The geometry and the material influence the homogeneity of the beam's current emitted by a cathode. In this paper we investigate the beam imprints of planar MPG-8 graphite cathode and carbon epoxy capillary cathode, Figure 1.

Figure 1 Planar MPG-8 graphite cathode (left). Smooth planar surface with capillaries attached to duralumin substrate (right).

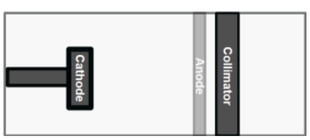

Figure 2 Experimental setup to obtain a full-beam imprint.

For the experimental procedure, an axial vircator was used. The experimental setup is shown in Figure 2. For obtaining the full beam imprint the radiochromic film was placed on top of the collimator overlooking the cathode. For obtaining the microbeams' imprint the film was placed behind the collimator. To calibrate the film a procedure similar to reference [1] was used.

II. RESULTS

A. Beam imprint

Figure 3 shows the imprint for the graphite cathode (left) and multi-capillary cathode (right). From the obtained prints we can see that the graphite cathode edges exhibit higher field strength than the centre of the emitting surface of the cathode this causes the dips in the centre of the cathode emitting surface. For the carbon epoxy multi-capillary cathode the beam imprint indicates a uniform distribution of the radiation dose (kGy) absorbed in the film over the electron-beam cross-section and had no dip in the beam density in the centre of the cathode.

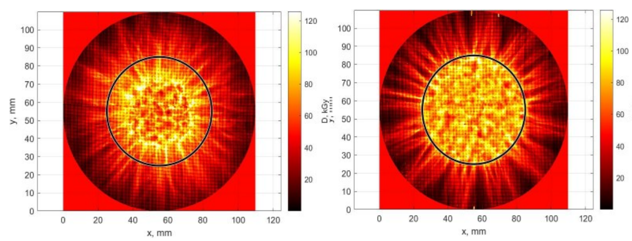

Figure 3 Beam imprint. Left is the planar MPG-8 graphite cathode and right is the multi-capillary cathode.

B. Microbeams' imprint

Using the pepper pot method [2], we obtained the beam imprint for the graphite cathode by measuring the displacement of the microbeams' centres relative to the centres of the collimating holes versus the hole position. From the microbeams' imprint, we were able to calculate the energy spread by calculating the characteristic angles of electron incidence on the anode surface based on the magnitudes of displacements and the thickness of the collimator (8mm). Results showed that the energy spread for the graphite cathode was approximately 16% this is considered really high but this is because graphite emitters have low uniformity [3].

III. CONCLUSION

To conclude, we highlighted the importance of the cathode emitter on its performance. Most importantly we experimentally determined the energy spread of the graphite cathode.

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