ISBA24

Investigating the Effects of Cathode-Anode Voltage and Number of Electron Emission on Electron Trajectory Simulation in 300 KeV Electron Beam Accelerator

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Particle Accelerators HUB OF TALENTS

ThEP

THAI SYNCHROTRON NATIONAL LAB

FITRAH ISLAMIC WORLD ACADEMY

OUTLINE

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1. Introduction

- Djoko S. Pudjorahardjo, and Suprapto [1]: In this study, the distance between the cathode and anode was varied from 7 mm to 20 mm, while the anode tilt angle was adjusted between 70° and 90°. The results demonstrated that a significant electron current was observed when the cathode-anode distance was minimized to 7 mm, and the anode tilt angle was set at 70°.

- Suprapto, Djoko SP., Djasiman [2]: A simulation conducted using a program developed by “The Andrzej Soltan Institute for Nuclear Studies”, Swierk-Poland, revealed that the trajectory of the electron beam approximates a straight line parallel to the axis at an anode voltage of 0.66 kV, with a beam current of 20 mA, a cathode-anode distance of 15 mm, and a cathode angle of 67.5°. After connecting the electron source to an accelerator tube with the first electrode voltage set at 15 kV relative to the anode, focusing was observed at a distance of approximately 34 mm from the cathode.

[1] Djoko S and Suprapto. ”Effect of Cathode-Anode Arrangement on Current Electrons in Thermionic Electron Sources,” P3TM-BATAN meeting proceedings and scientific presentations (1999).
[2] Suprapto et al, ”Simulation of Electron Beam Tracks in Thermionic Type Electron Sources with Pierce Electrodes,” Proceedings of the National Seminar on Accelerator Technology and The application, Vol. 2, No. 1 (2000)

1. Introduction

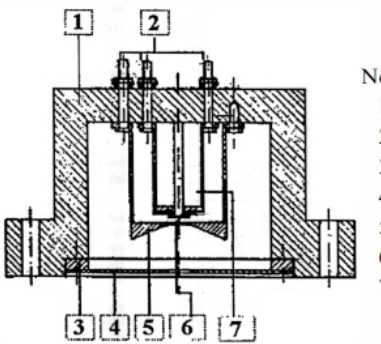
- Suprapto, Djoko SP., Djasiman [3]: The electron beam profile from the electron source in previous studies [2] did not meet the requirements for the EBM. Consequently, the electron source was reconstructed with modifications, including adjustments to the body, focusing electrode, and filament design. The resulting electron beam at a cathode-anode voltage of 2 kV produced a current of 15 mA.

- Suprapto et al [4]: The electron beam simulation was conducted using the Opera 3D software with configurations, including: (i) the cathode, focusing electrode, and anode holder were connected (with the anode removed), and (ii) the cathode and focusing electrode were connected, while the anode was installed with varying extraction voltages or cathode-anode voltages of 5 kV, 10 kV, and 15 kV.

[3] Suprapto et al, "Reconstruction of Thermionic Electron Sources with Pierce Electrode For EBM 500 Kev/10 mA," Proceedings of the Meeting and Scientific Presentation of Basic Research in Nuclear Science and Technology P3TM-BATAN (2001)

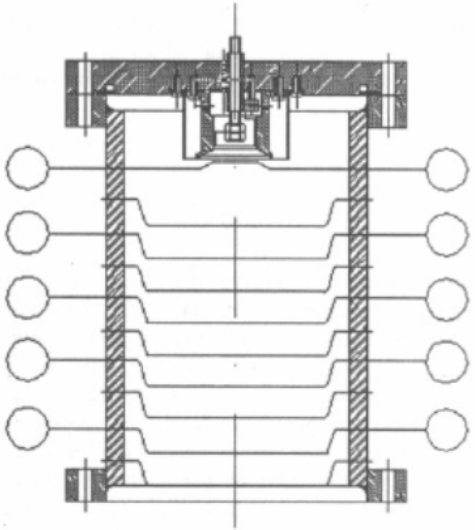
[4] Suprapto. "Modification of The Electron Source And Simulation of The Electron Beams Track on The EBM Accelerate Tube in PSTA," Proceedings of the National Seminar on Accelerator Technology and The application, Vol. 17, 75-84 (2015).

2. Methodology



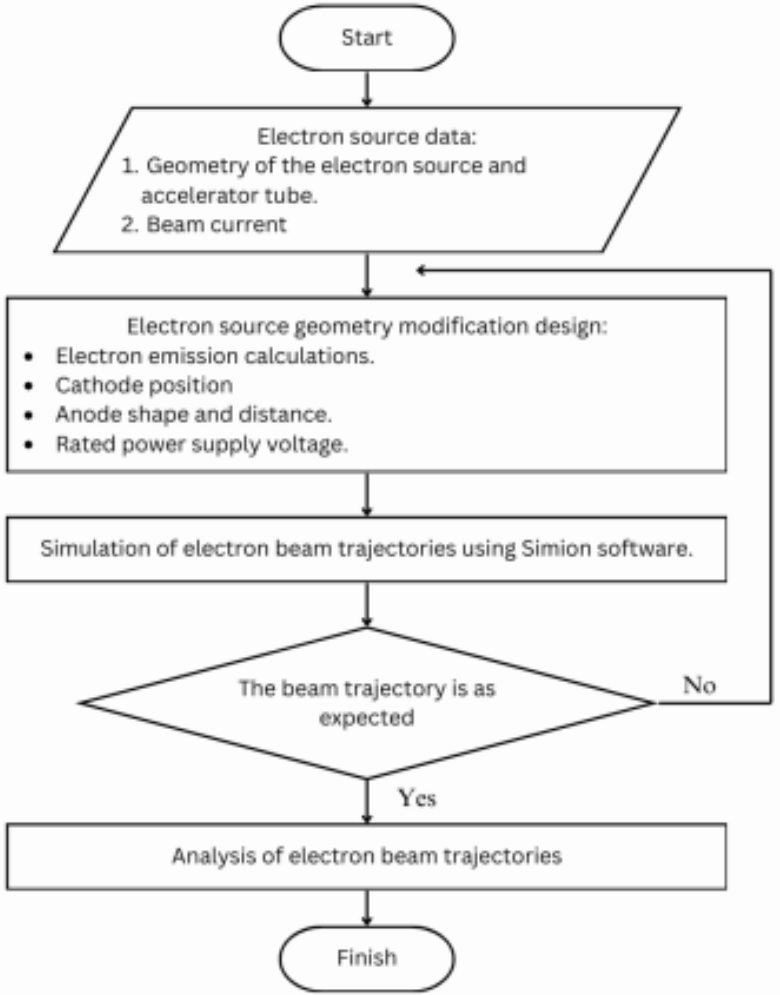
(a)

Note:
1. Body
2. Power supply terminals
3. Anode ring
4. Anode
5. Cathode
6. Filament
7. Filament holder

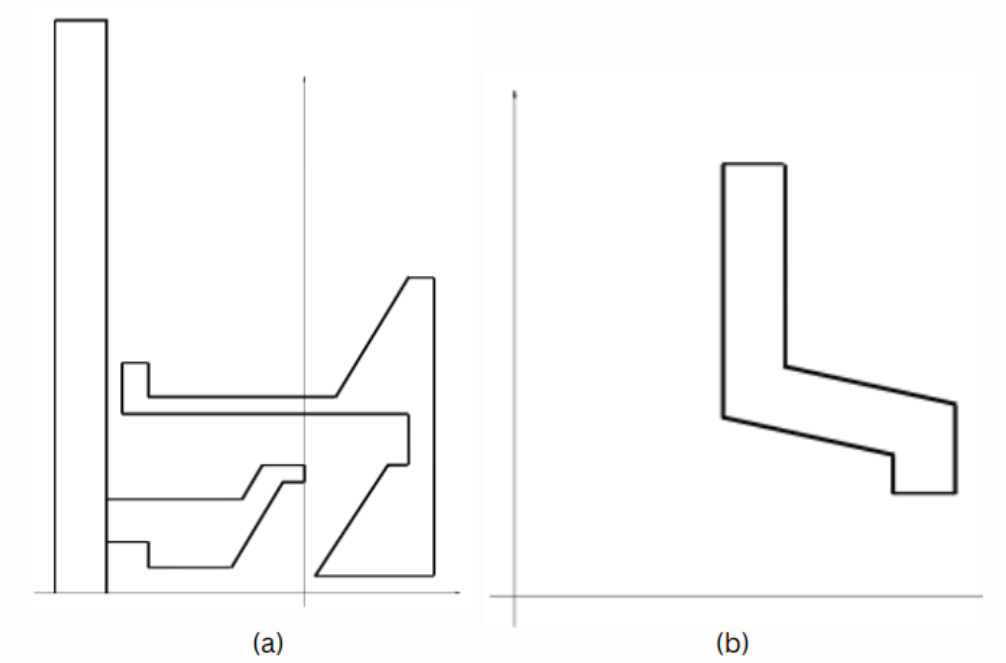


(b)

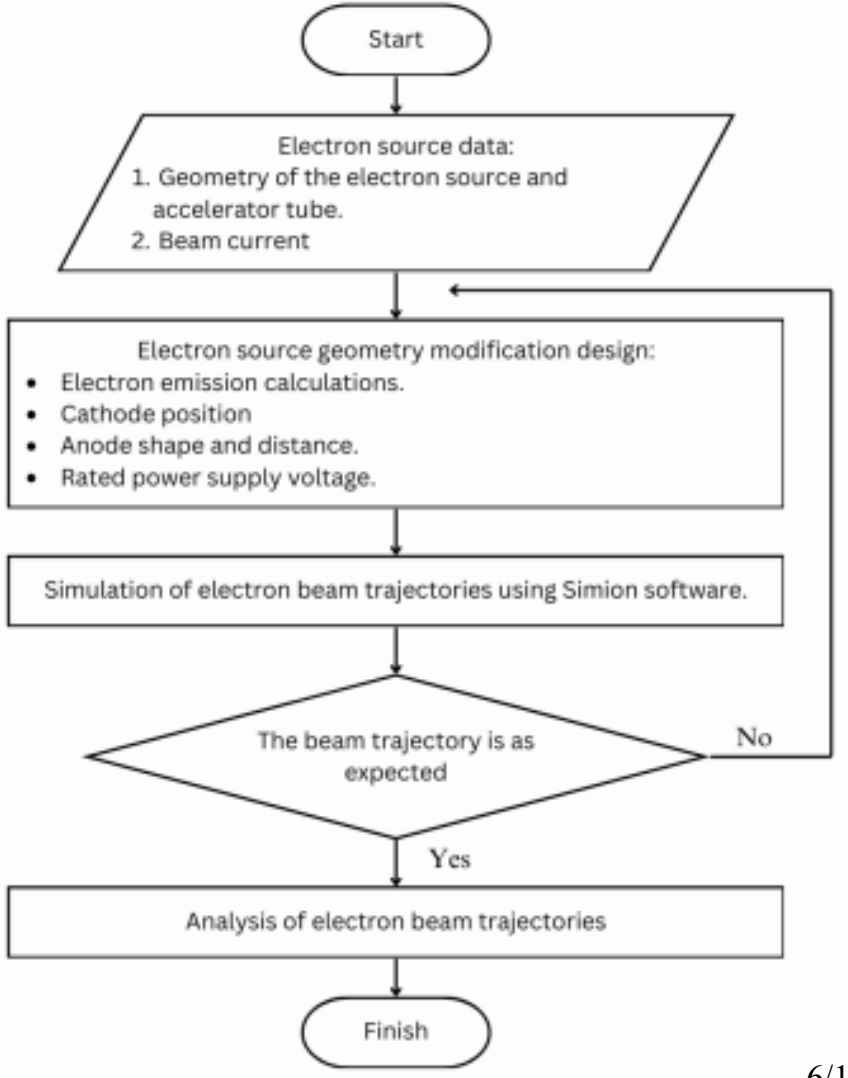
(a) Mechanical design of electron source construction,
(b) Construction of the electron source in the accelerator tube.



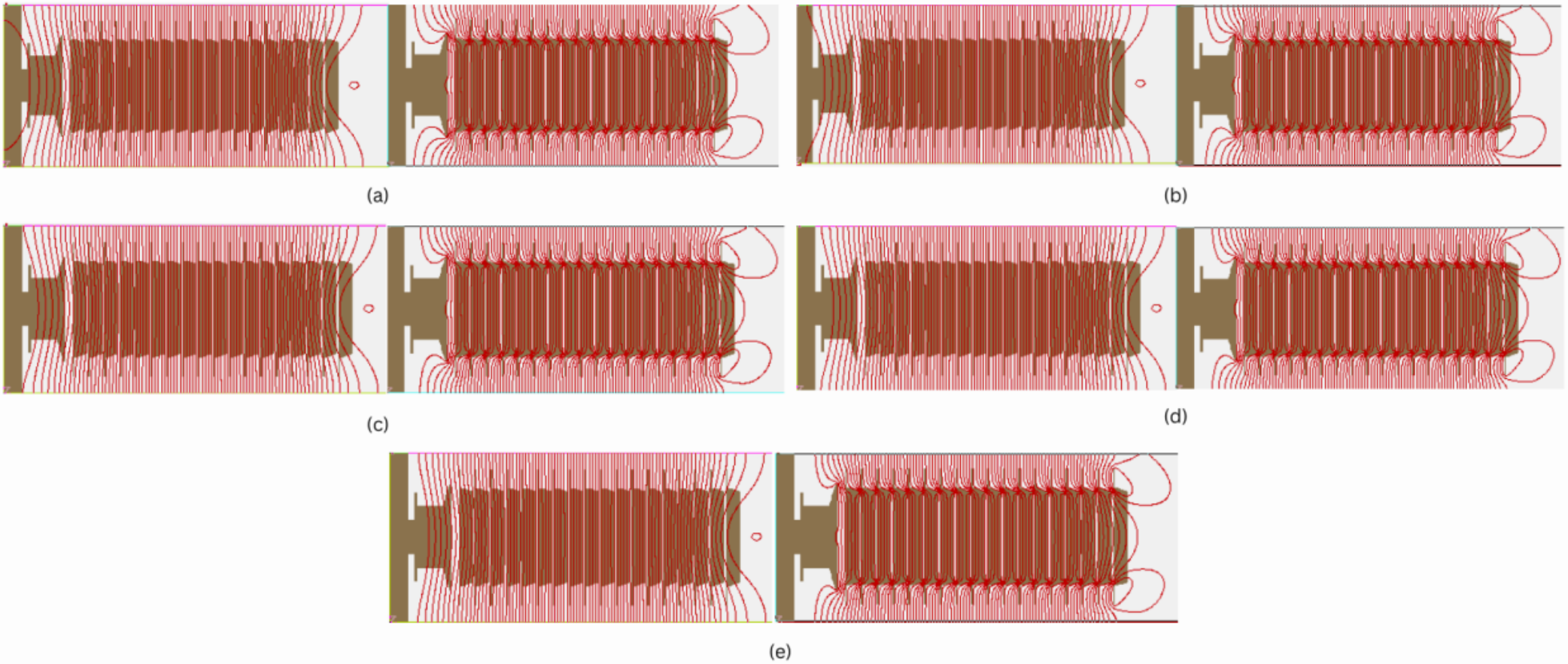
2. Methodology



(a) Geometric design of Cathode-Anode,
(b) Geometric design of the accelerator electrode

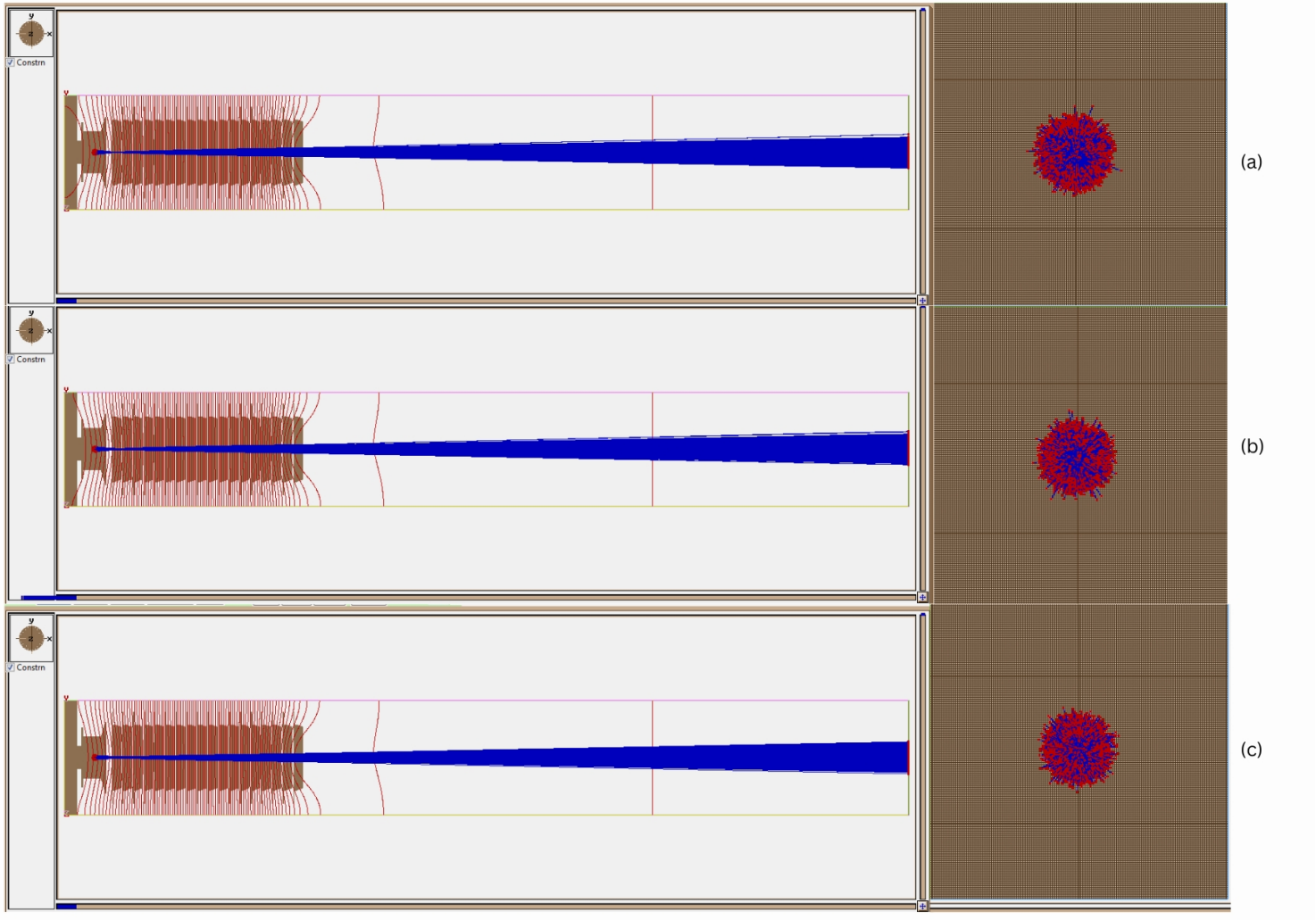


3. Results and Discussions



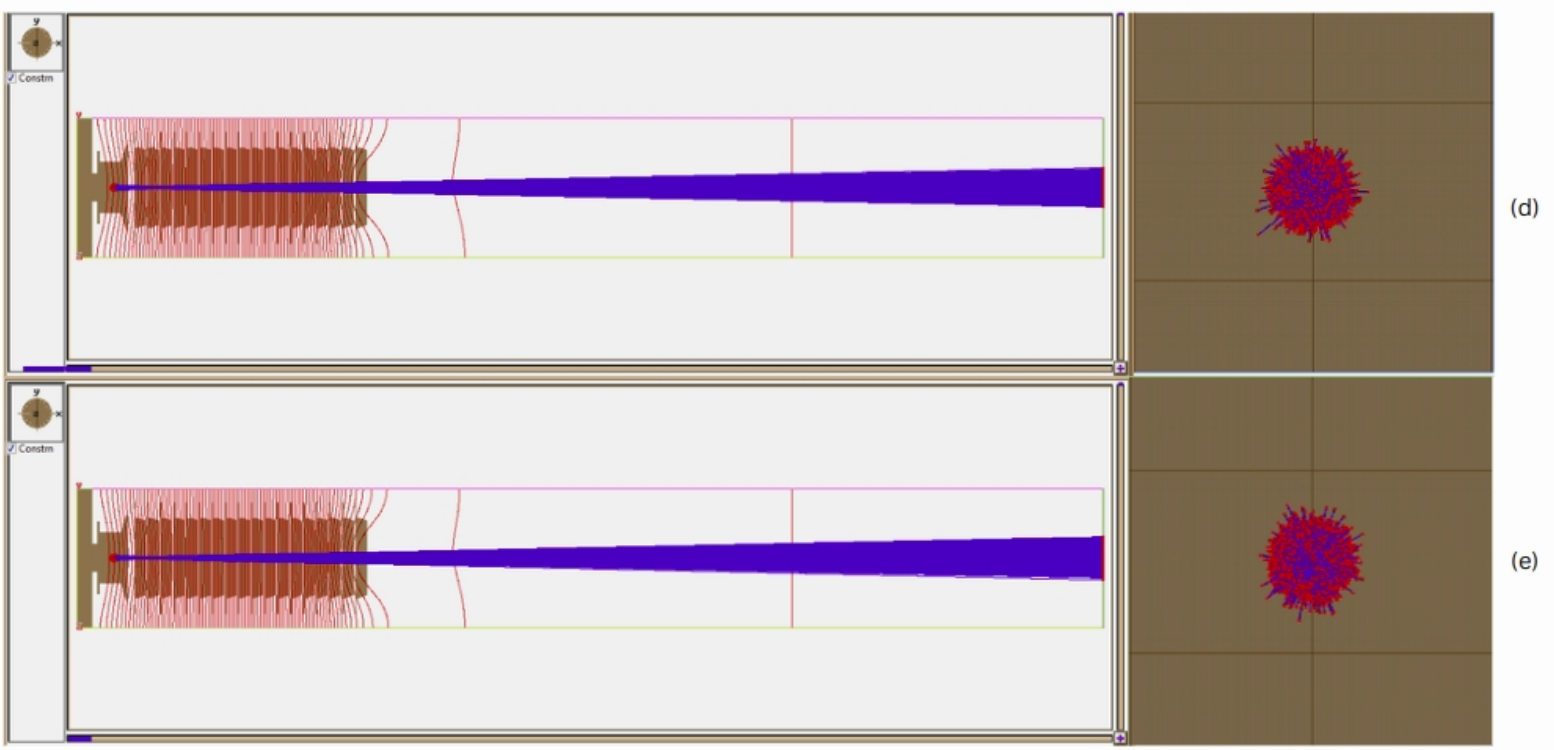
Equipotential Field Lines of Cathode-Anode Voltage (a) 2 kV, (b) 4 kV, (c) 6 kV, (d) 8 kV, (e) 10 kV

3. Results and Discussions



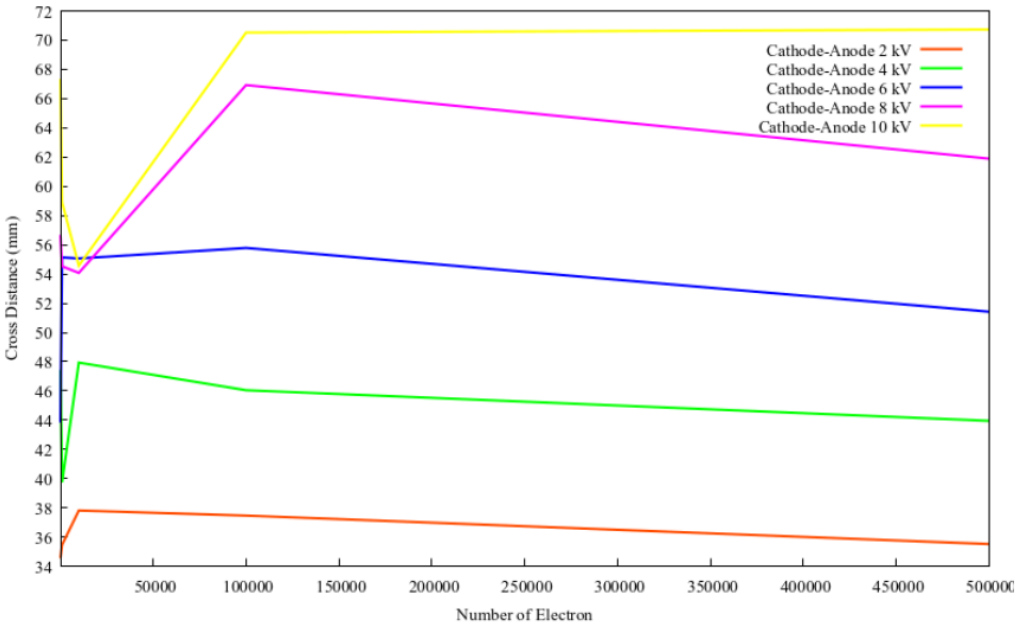
Electron beam trajectory and equipotential field for cathode-anode voltage (a) 2 kV, (b) 4 kV, (c) 6 kV

3. Results and Discussions

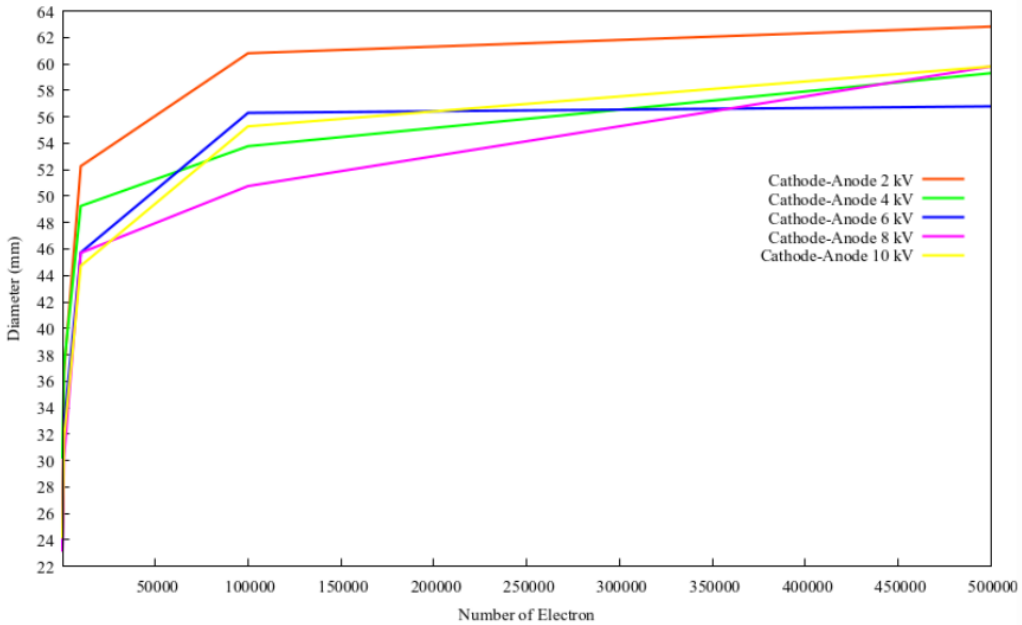


Electron beam trajectory and equipotential field for cathode-anode voltage (d) 8 kV, (e) 10 kV.

3. Results and Discussions



(a)



(b)

(a) Cross distance or distance of the focused beam from the electron source (mm) with variations in cathode-anode voltage and number of electrons,
(b) Diameter of the electron beam in the window with variations in cathode-anode voltage and number of electron particles.

4. Conclusion

- The difference in cathode-anode voltage, specifically at 2 kV, 4 kV, 6 kV, 8 kV, and 10 kV, significantly influences the equipotential field in the cathode-anode region. This variation leads to differences in the energy extraction necessary for the acceleration of electrons from the electron source. Consequently, these differences affect the focal distance or the intersection point of the electron beam generated from the electron source.

- The increase in cathode-anode voltage can extend the focal distance or intersection point of the electron beam from the electron source. This adjustment results in a decrease in the diameter of the window, with the smallest diameter achieved measuring 5.52 ± 0.05 mm at a cathode-anode voltage of 6 kV.

- As the number of electrons emitted from the source increases, the focal distance of the beam intersection extends further from the electron source, while the beam diameter remains relatively unchanged without significant variation.