

H- Ion Beam Characterization

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OUTLINE

- Ion sources.
 - Current density measurements.
 - Current density data analysis.
 - Experimental Results and Observations.
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The Desired Ion Beam

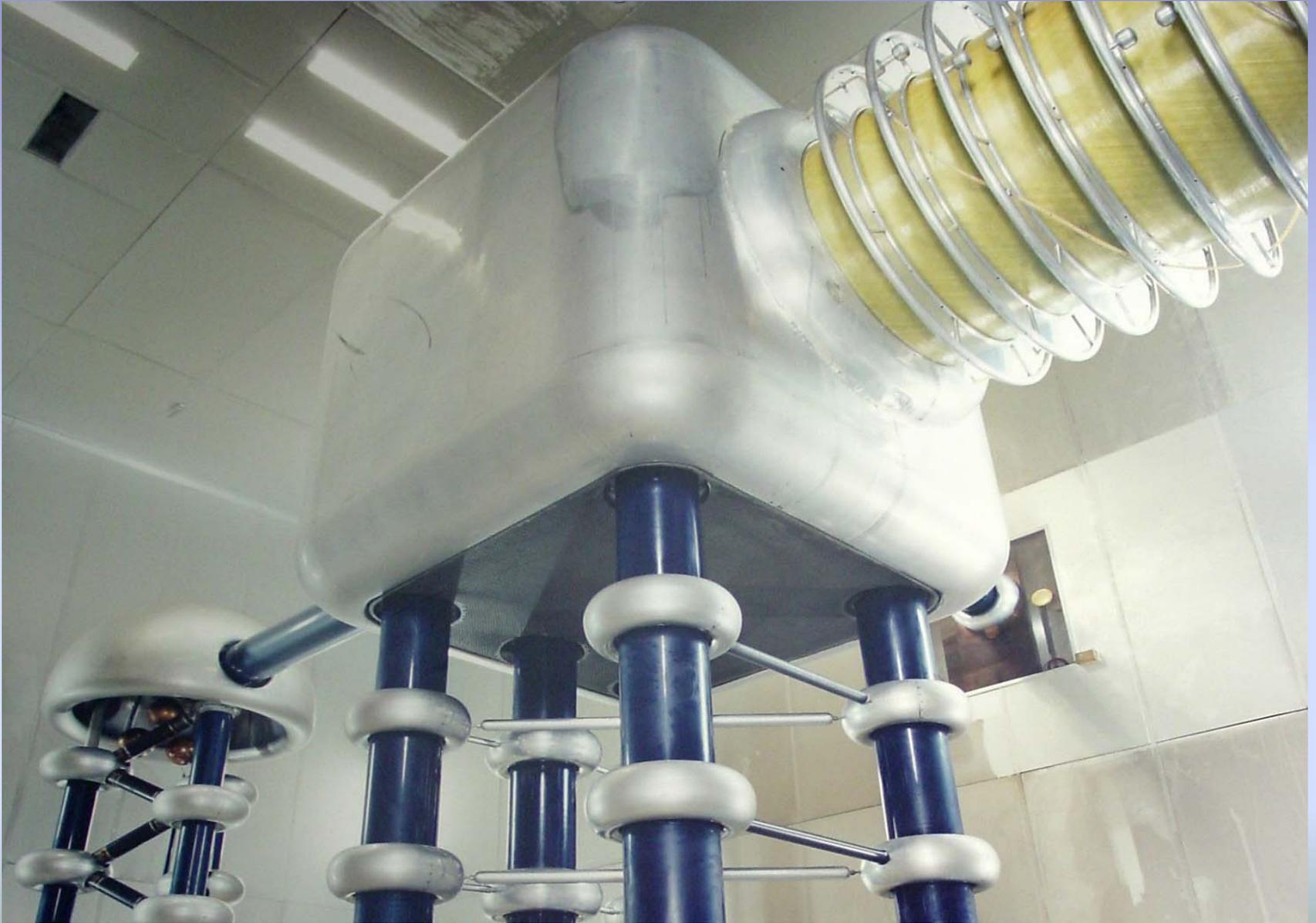
- High current density.
 - Small emittance.
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Space Charge

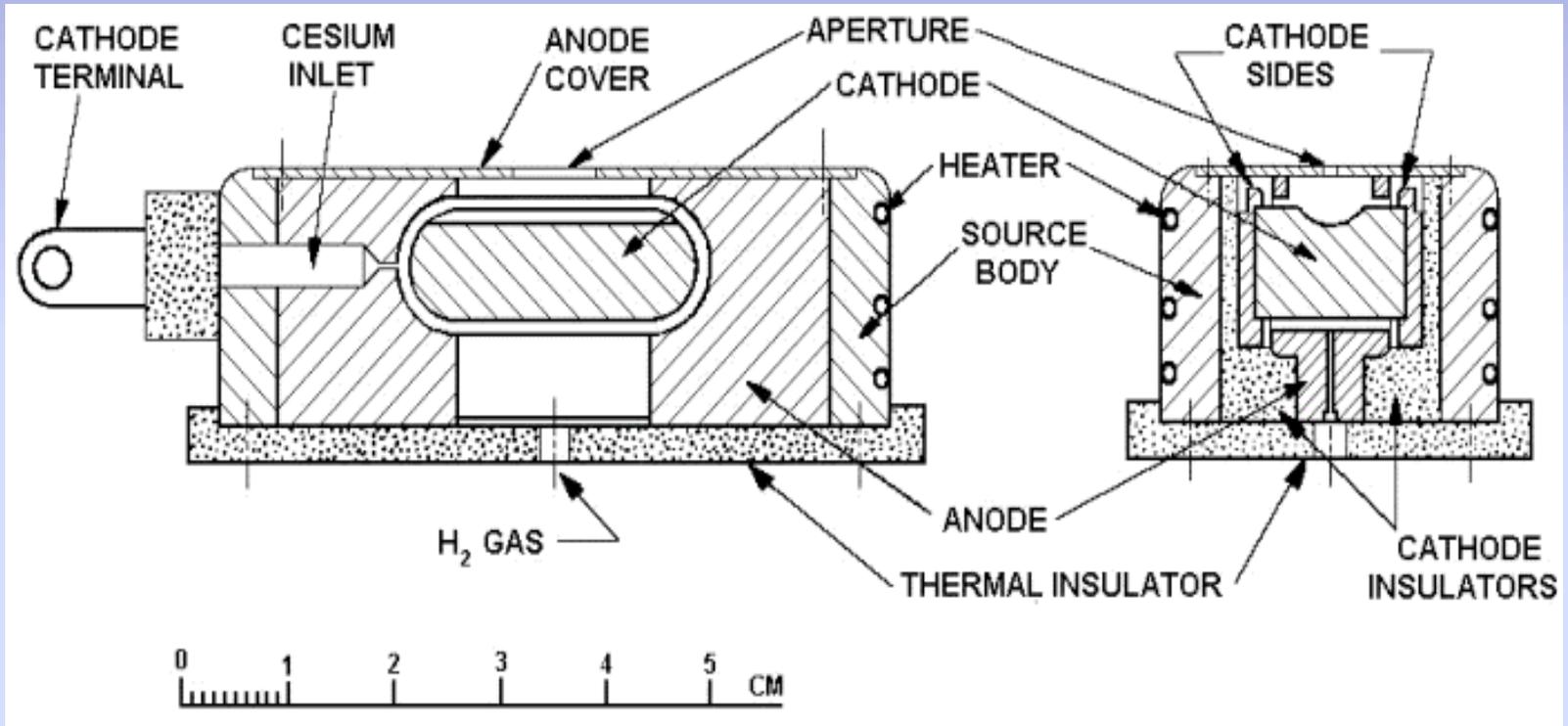
1. Charged particles in an ion beam repel.
 2. The diameter of the ion beam increases.
 3. Current density decreases.
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The H⁻ Ion Source

The Cockcroft-Walton

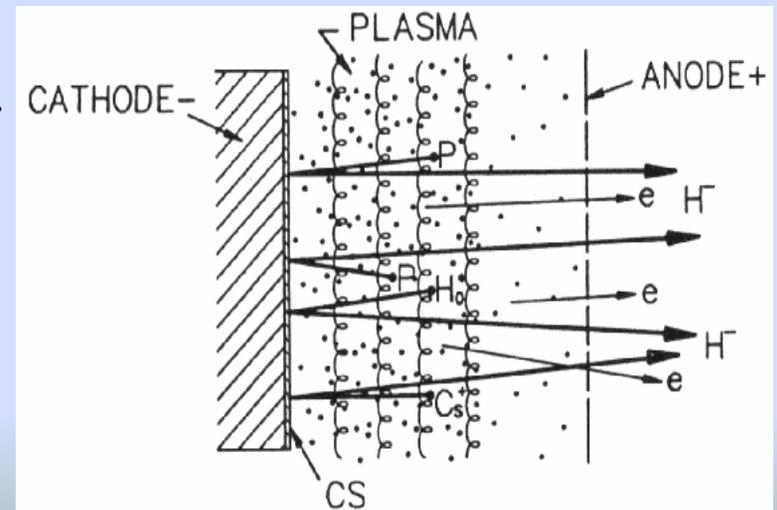
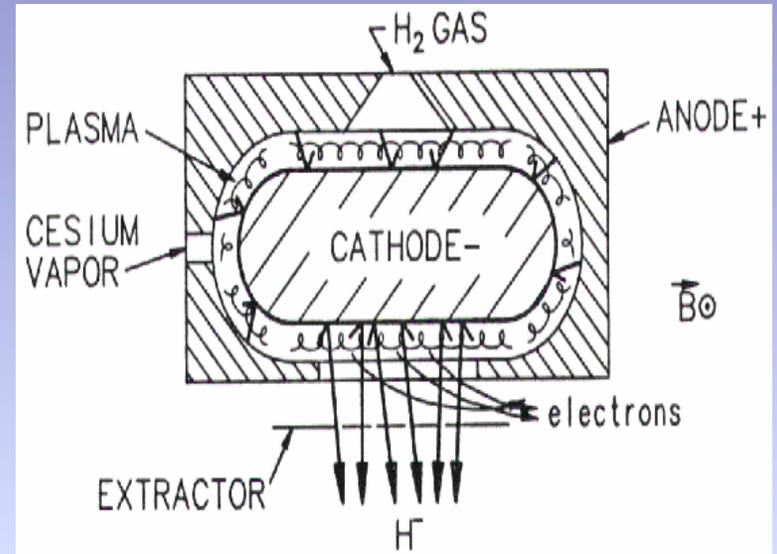


H- MAGNETRON SOURCE

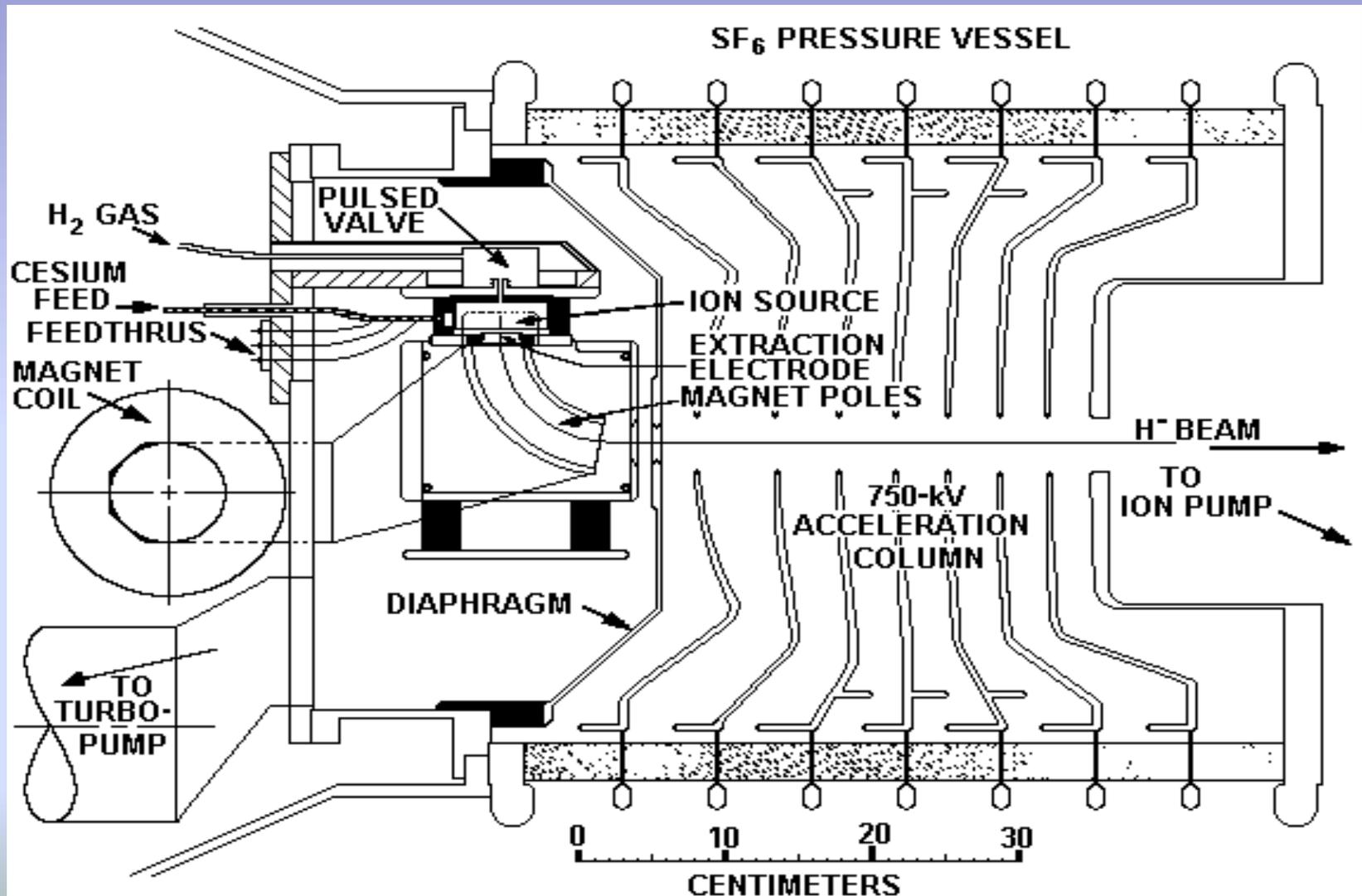


H- ION FORMATION

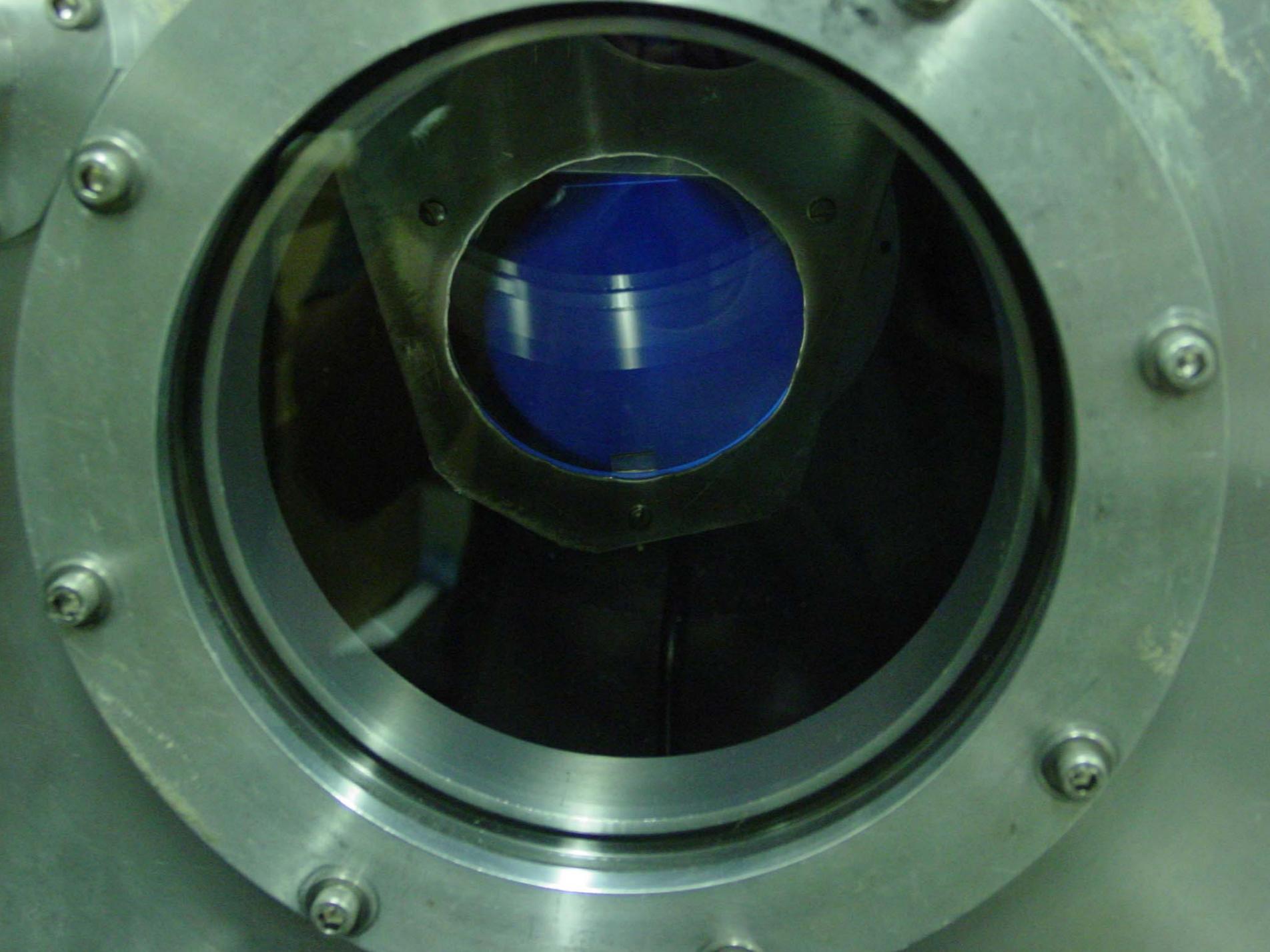
1. High voltage between the cathode and anode causes electrons in the cathode surface to be ejected into the chamber.
2. The $E \times B$ field makes the electrons to travel in helical orbits.
3. Hydrogen is added to the chamber.
4. A plasma is formed in the chamber, which produces protons.
5. Protons are accelerated toward the cathode.
6. The protons collide with the surface of the cathode obtaining by different methods two electrons.
7. Newly created H^- are extracted from the chamber.



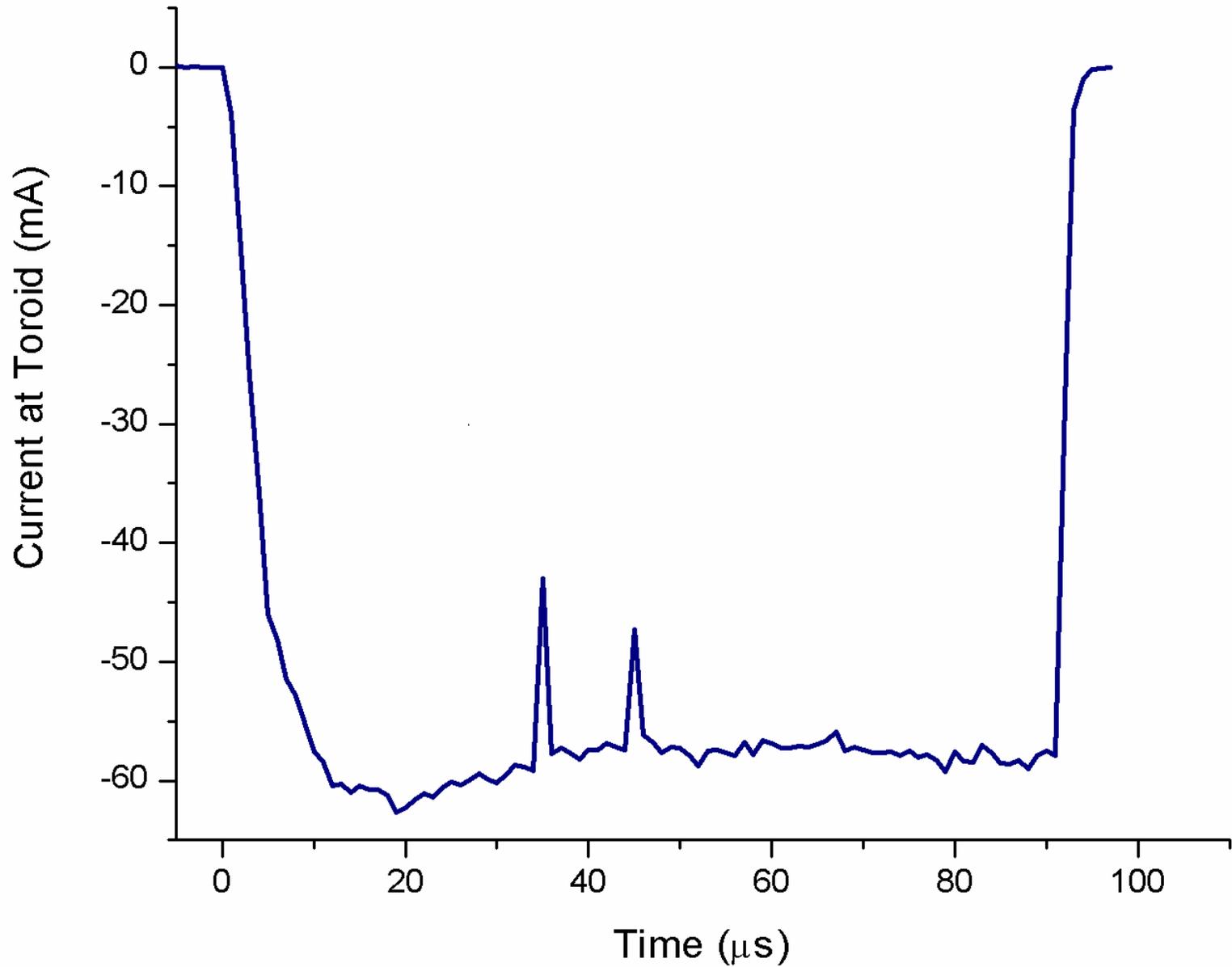
H- ION SOURCE ASSEMBLY

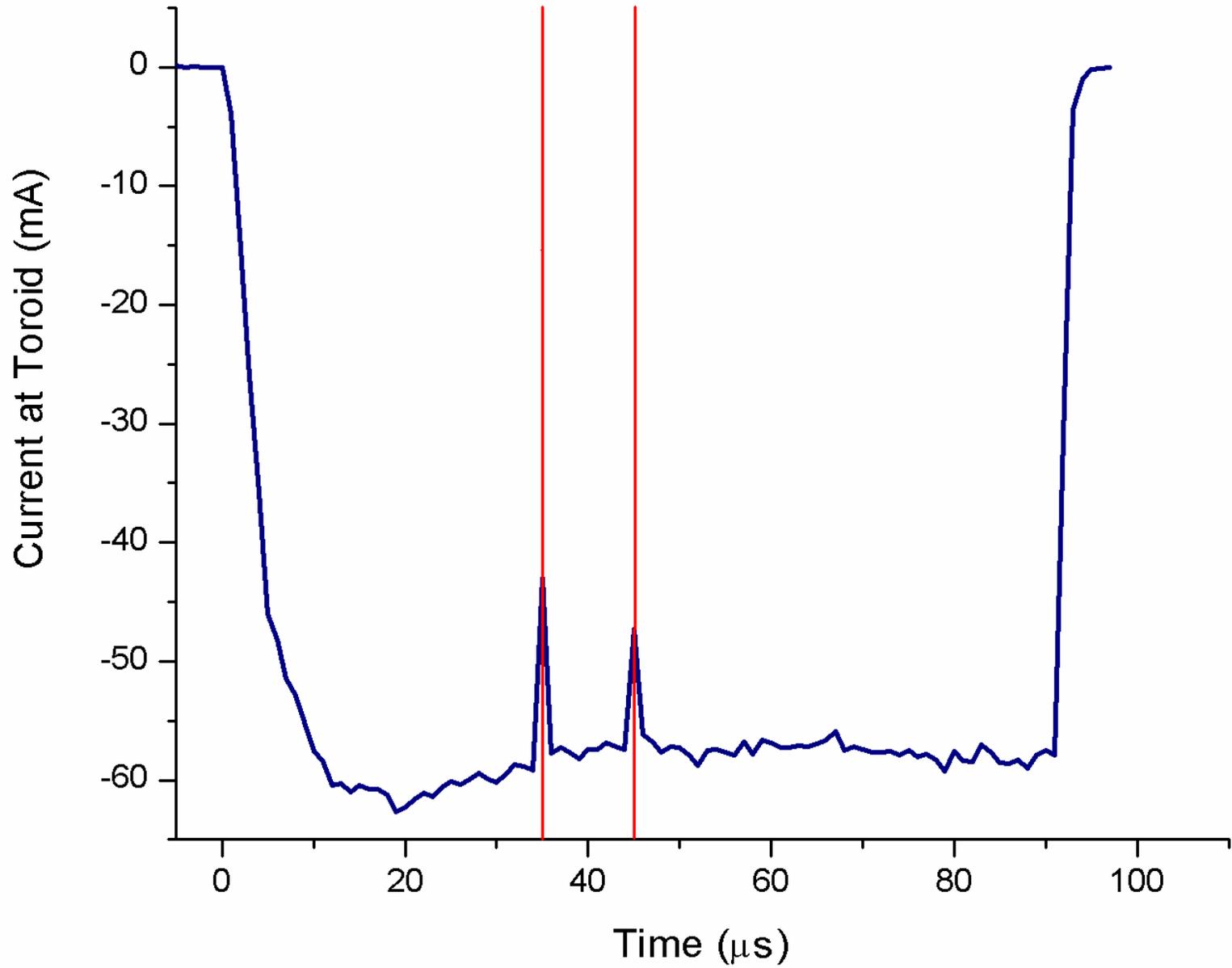


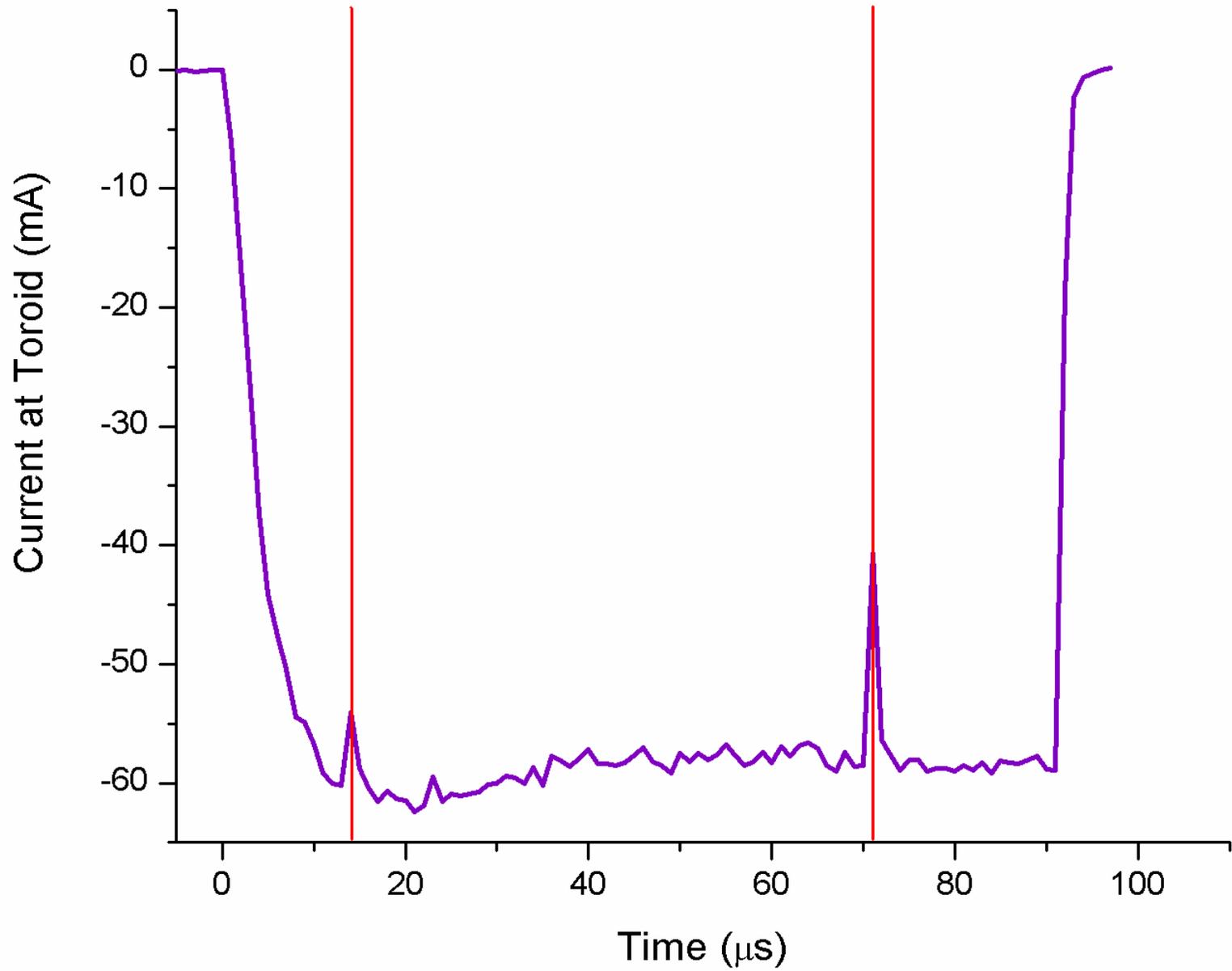




THE ION BEAM PULSE





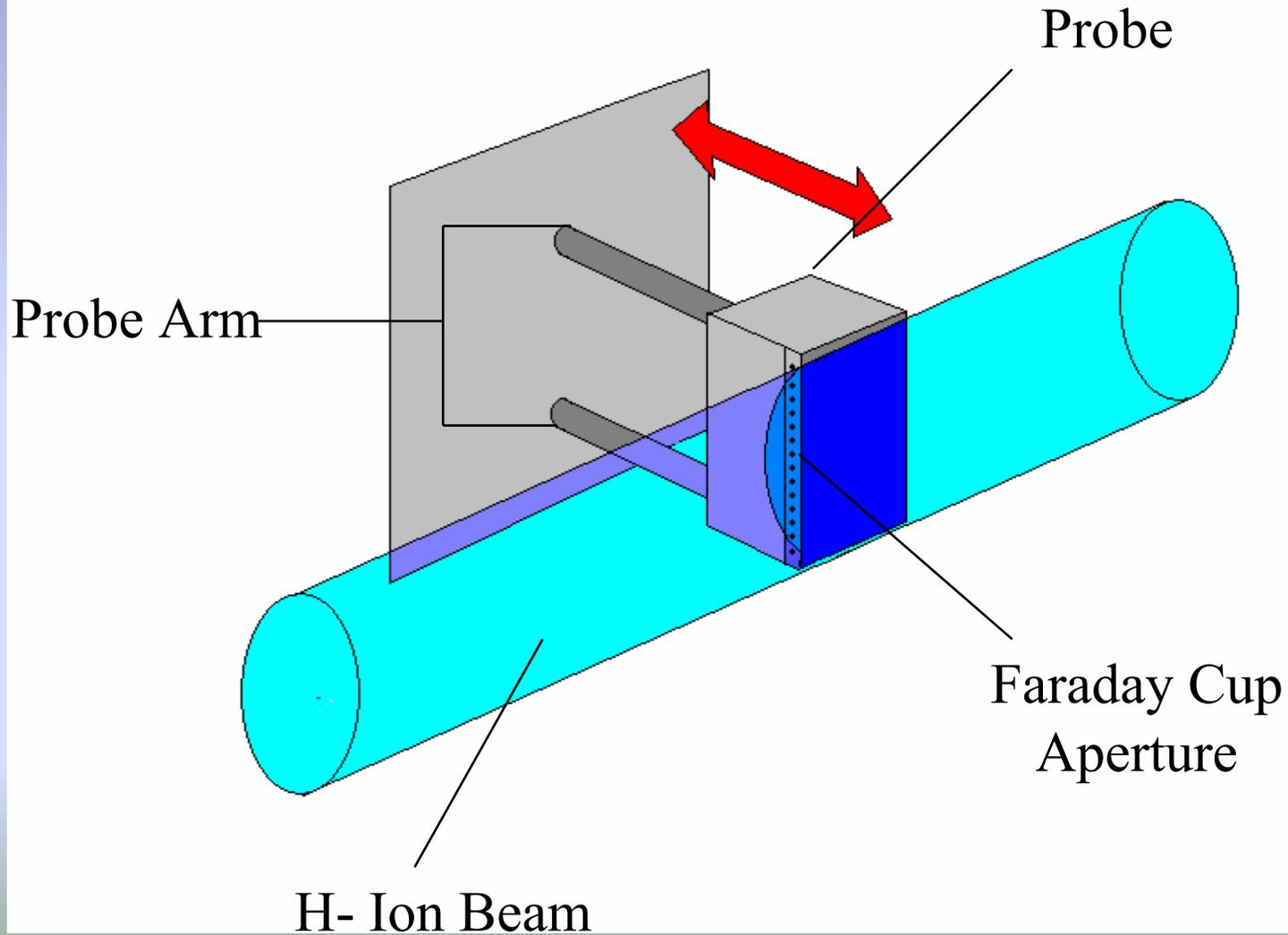




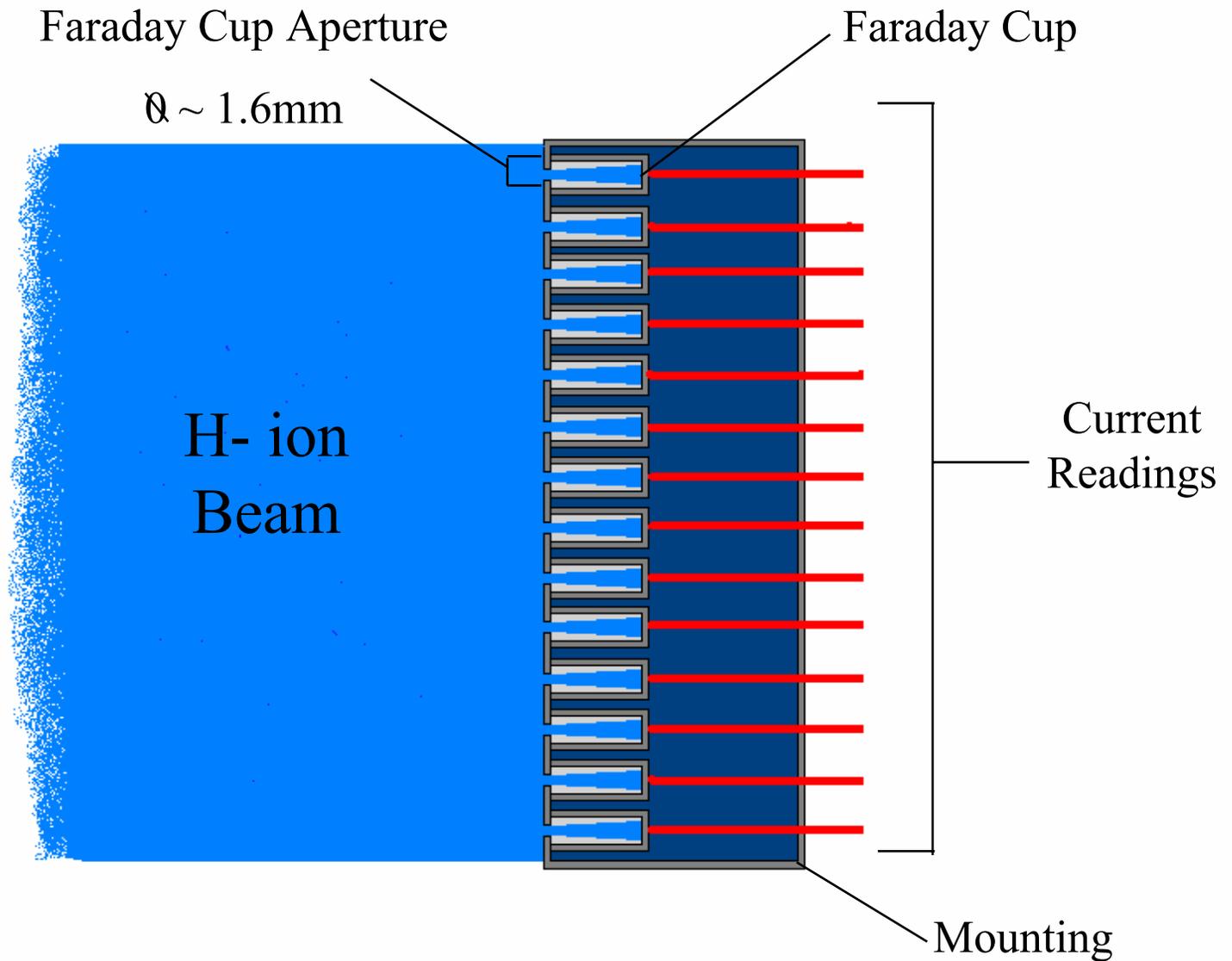
Data Acquisition



CURRENT DENSITY PROBE



FARADAY CUP ARRAY



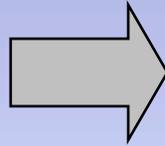


Data Analysis

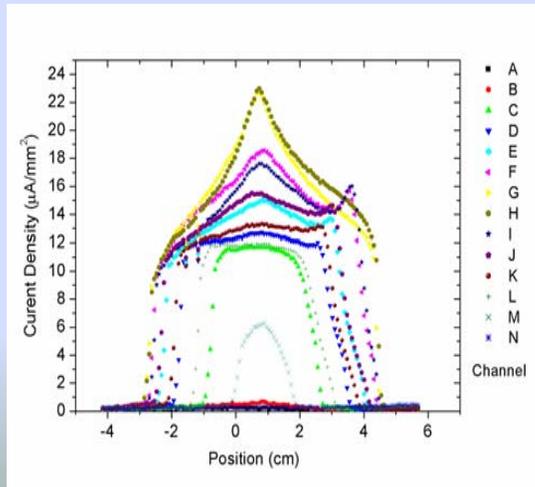
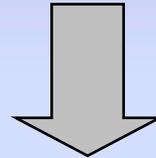


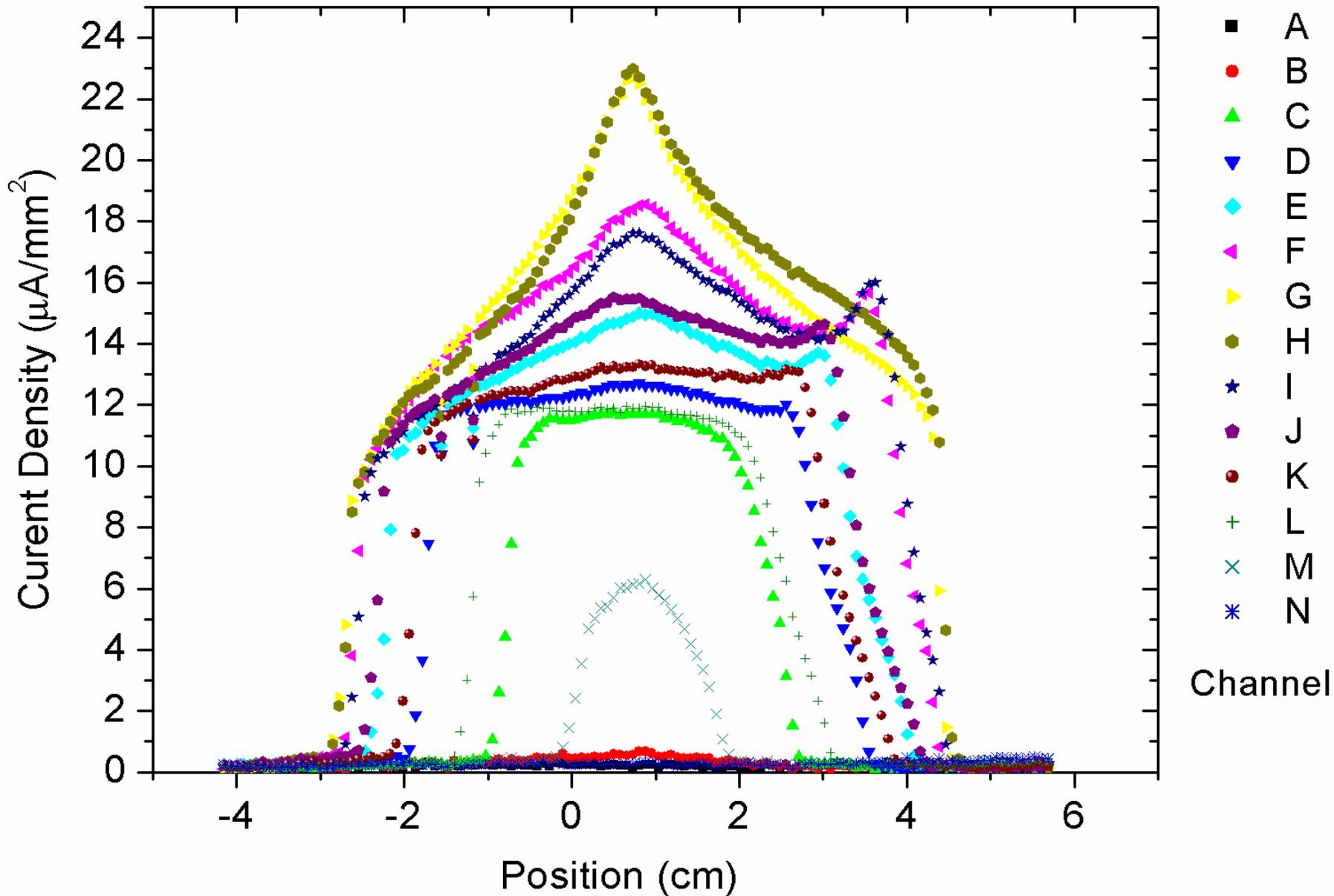
DATA ANALYSIS

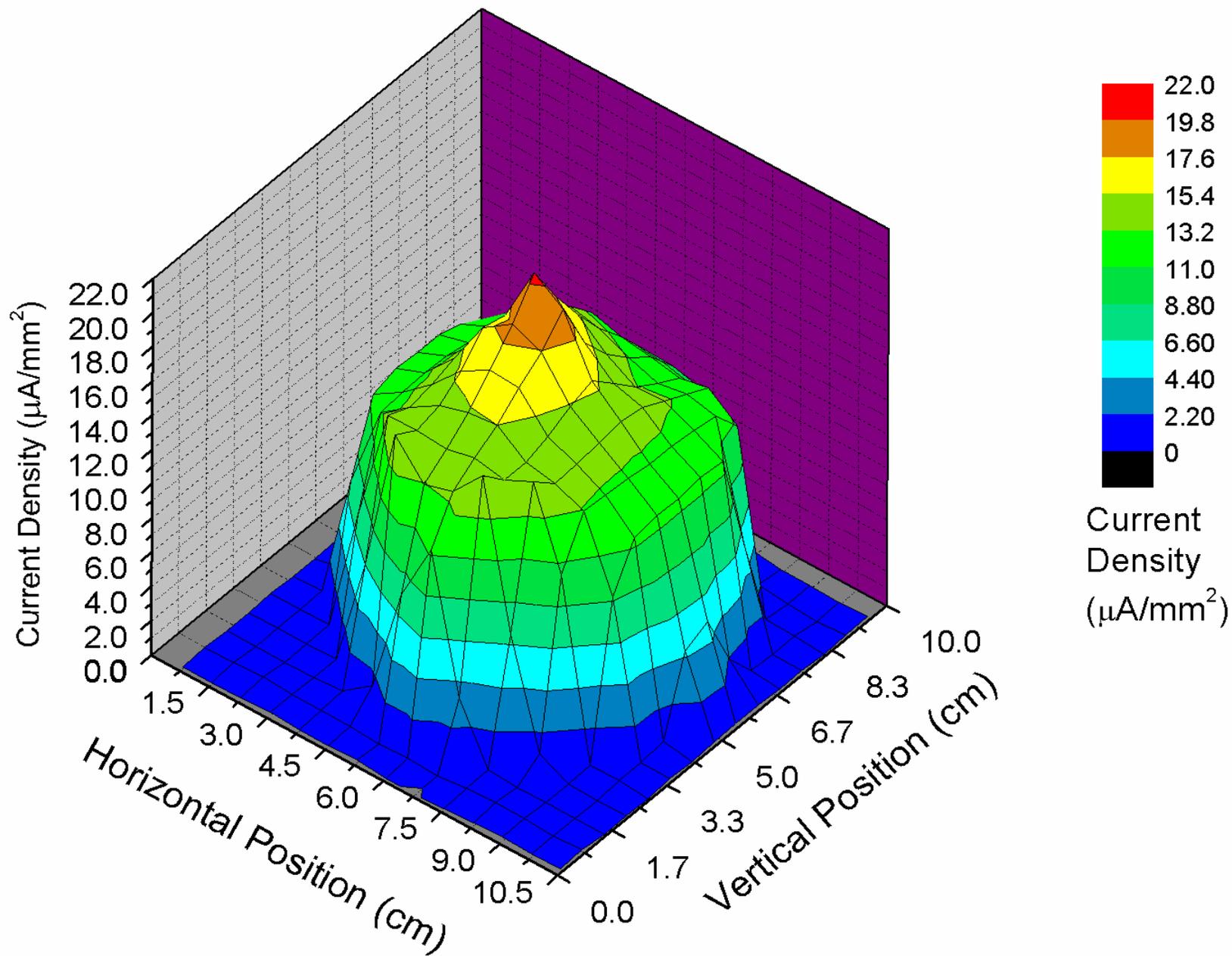
Data File



Conversion to
Current Density
($\mu\text{A}/\text{mm}^2$)



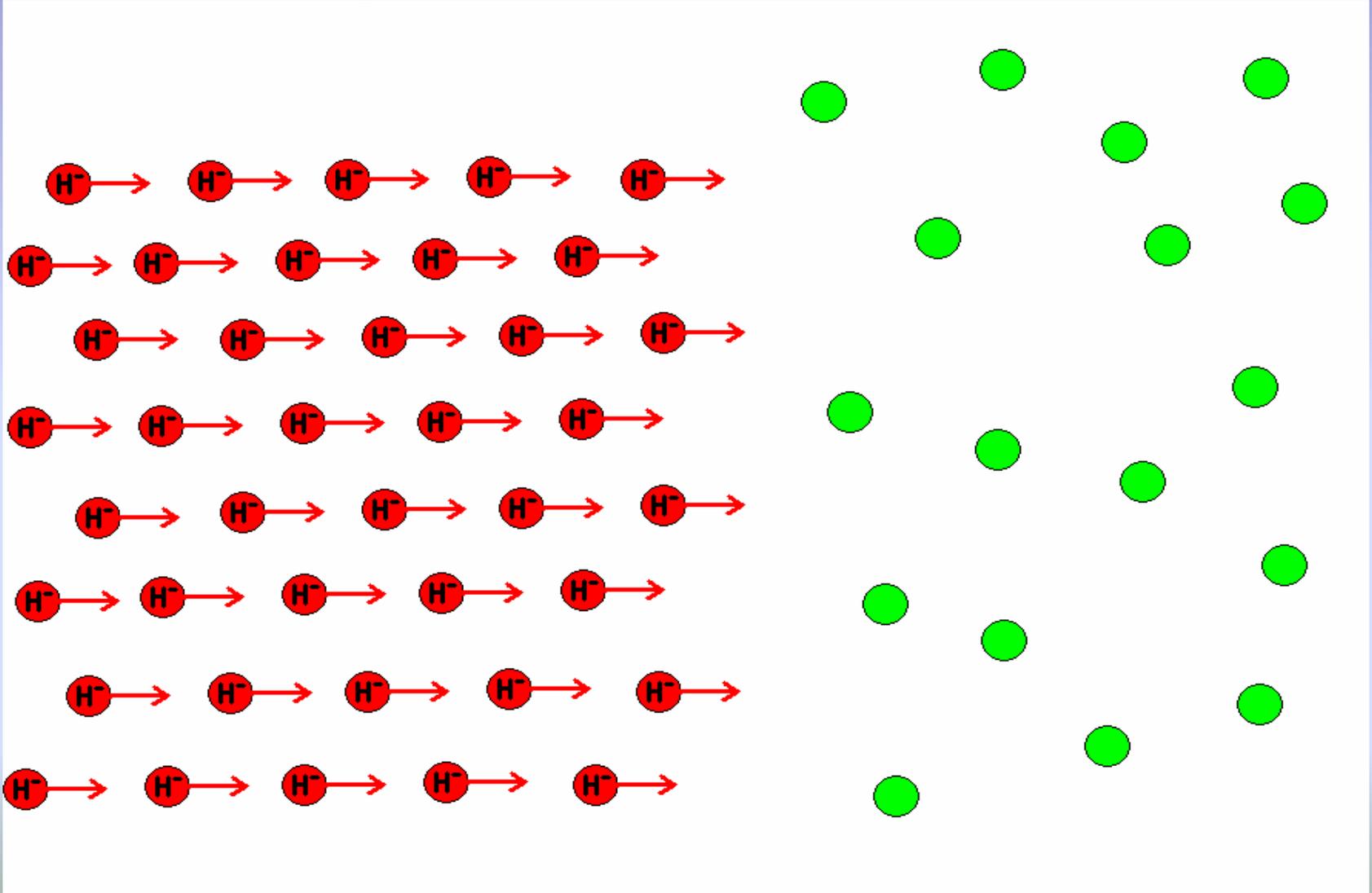




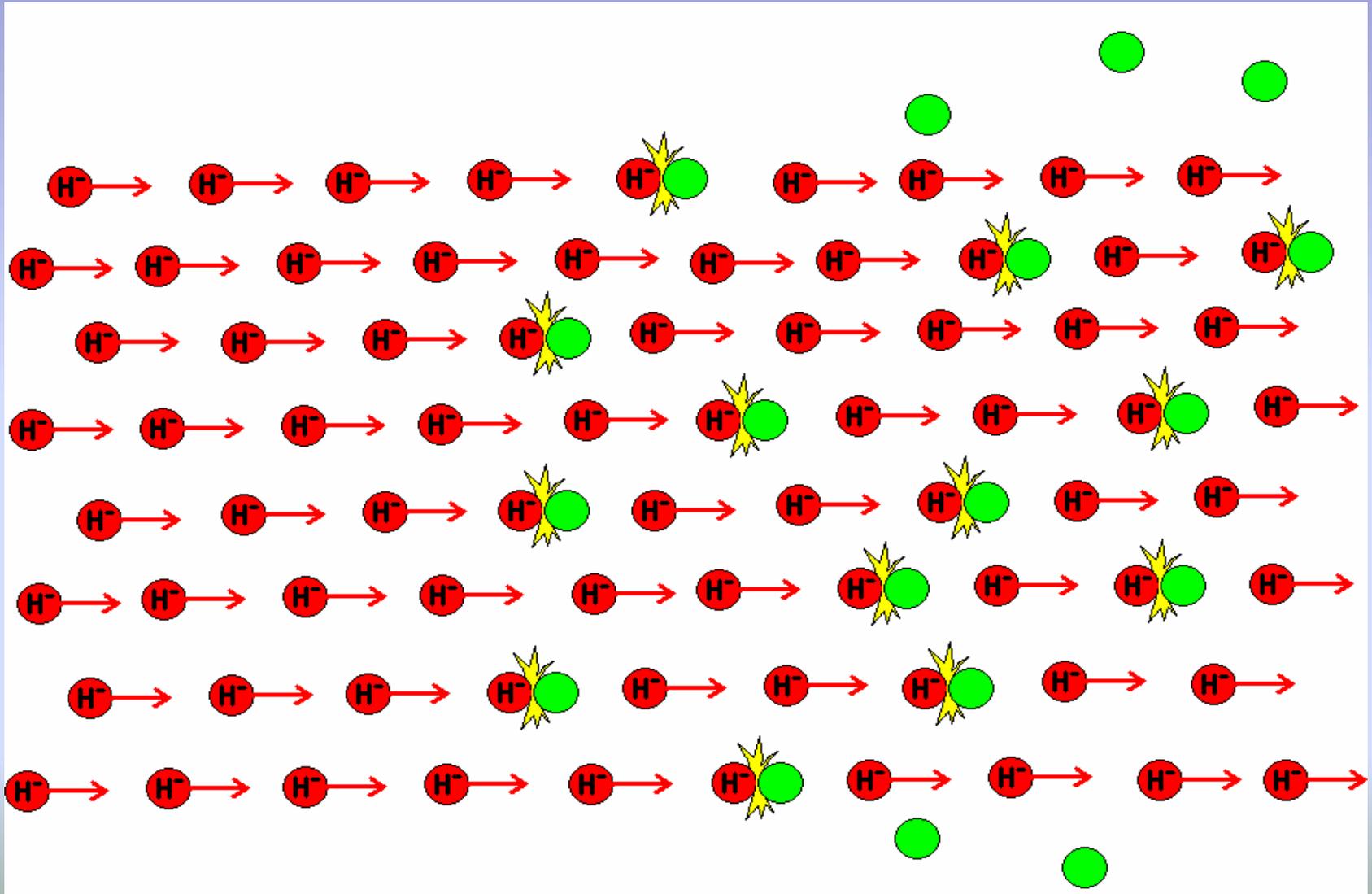
Space Charge Neutralization

- Particles of the opposite charge partially neutralize the net electric charge in a region of an ion beam.
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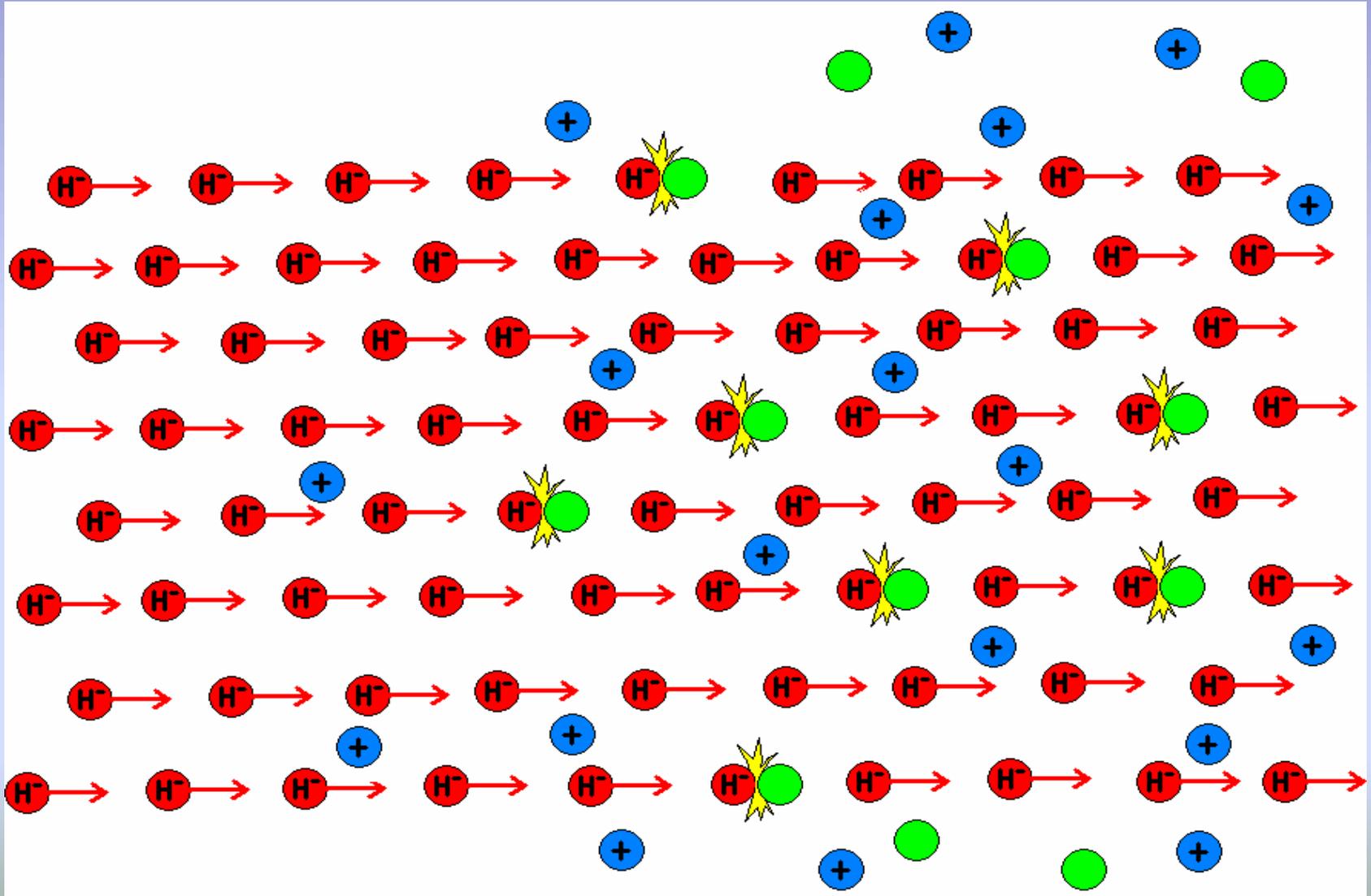
1. The H^- ions travel through the vacuum where neutral atoms are present.



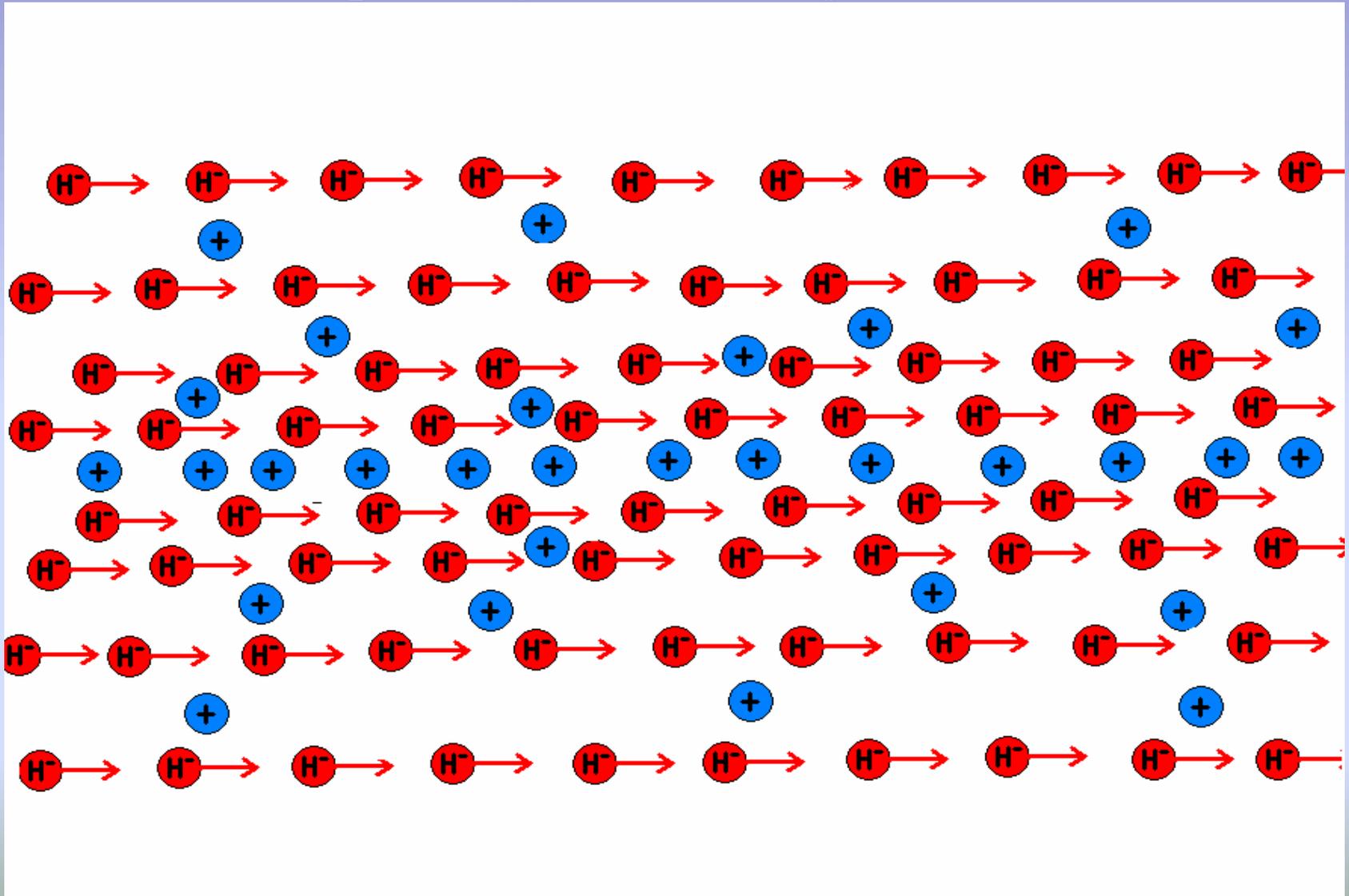
2. The H⁻ ions collide with the neutral atoms.



3. Some positive ions are created as a result of the collisions.

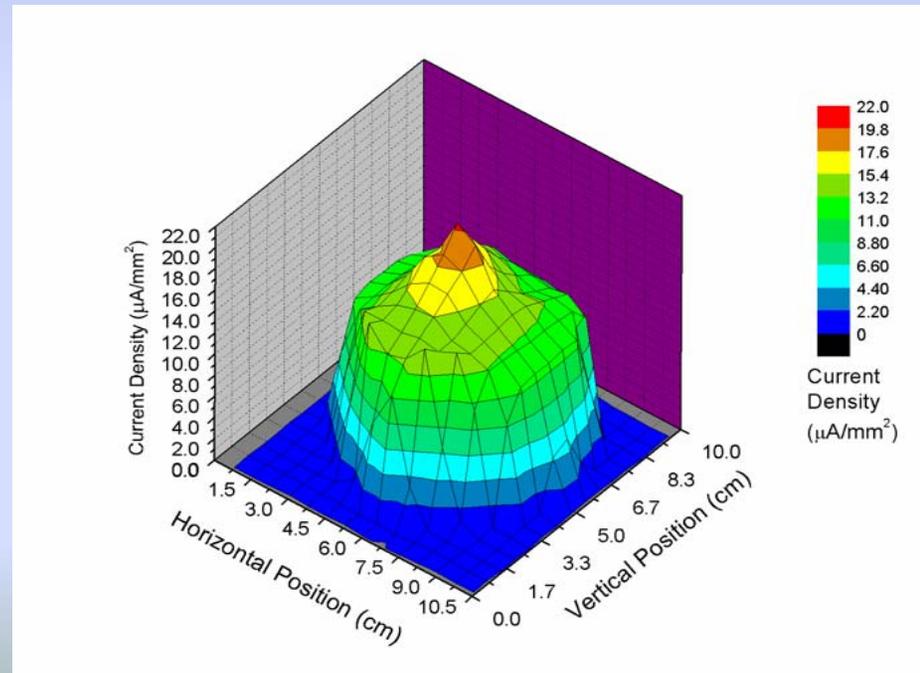


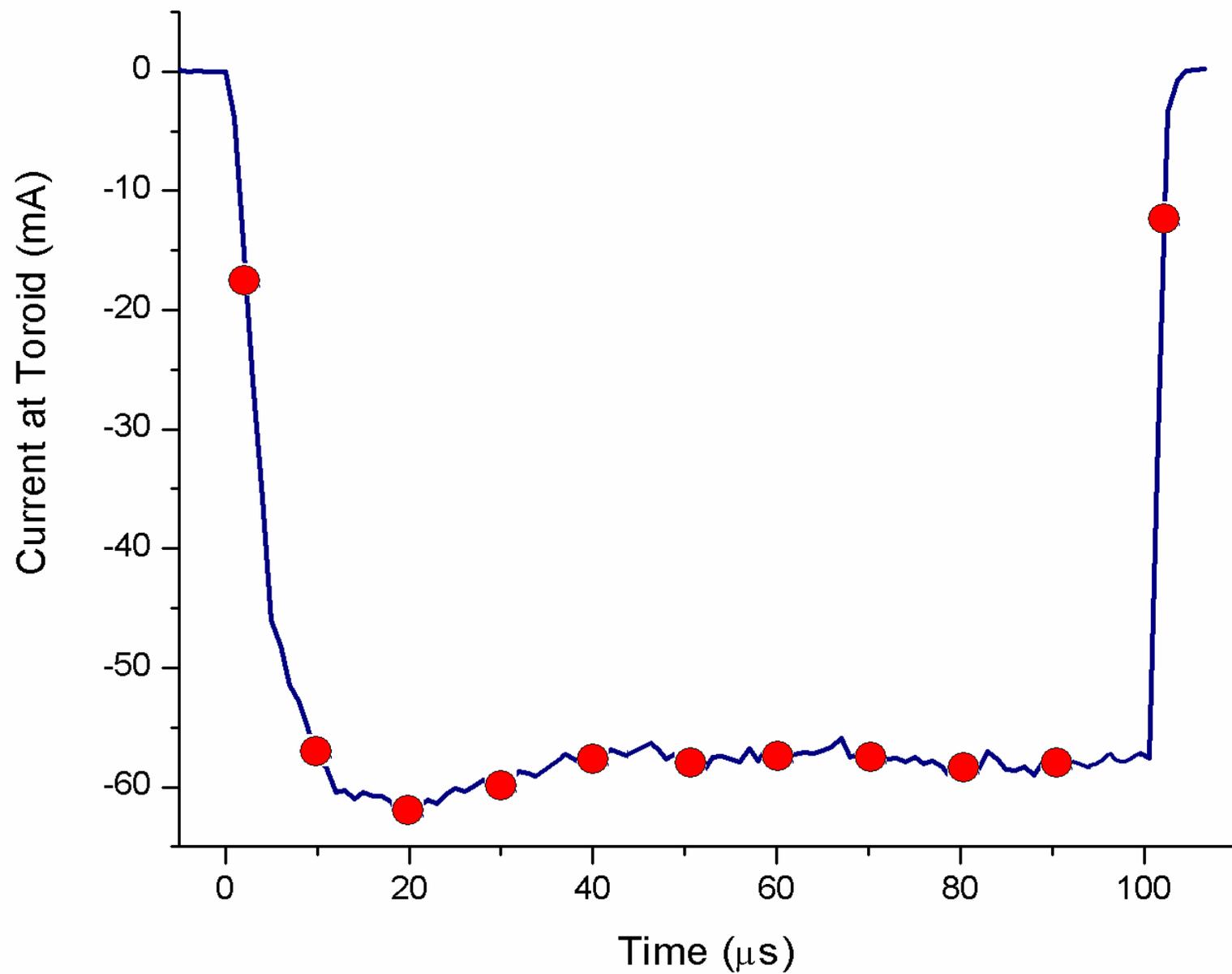
4. The positive ions are attracted toward the center of the beam, partially neutralizing the net E field.

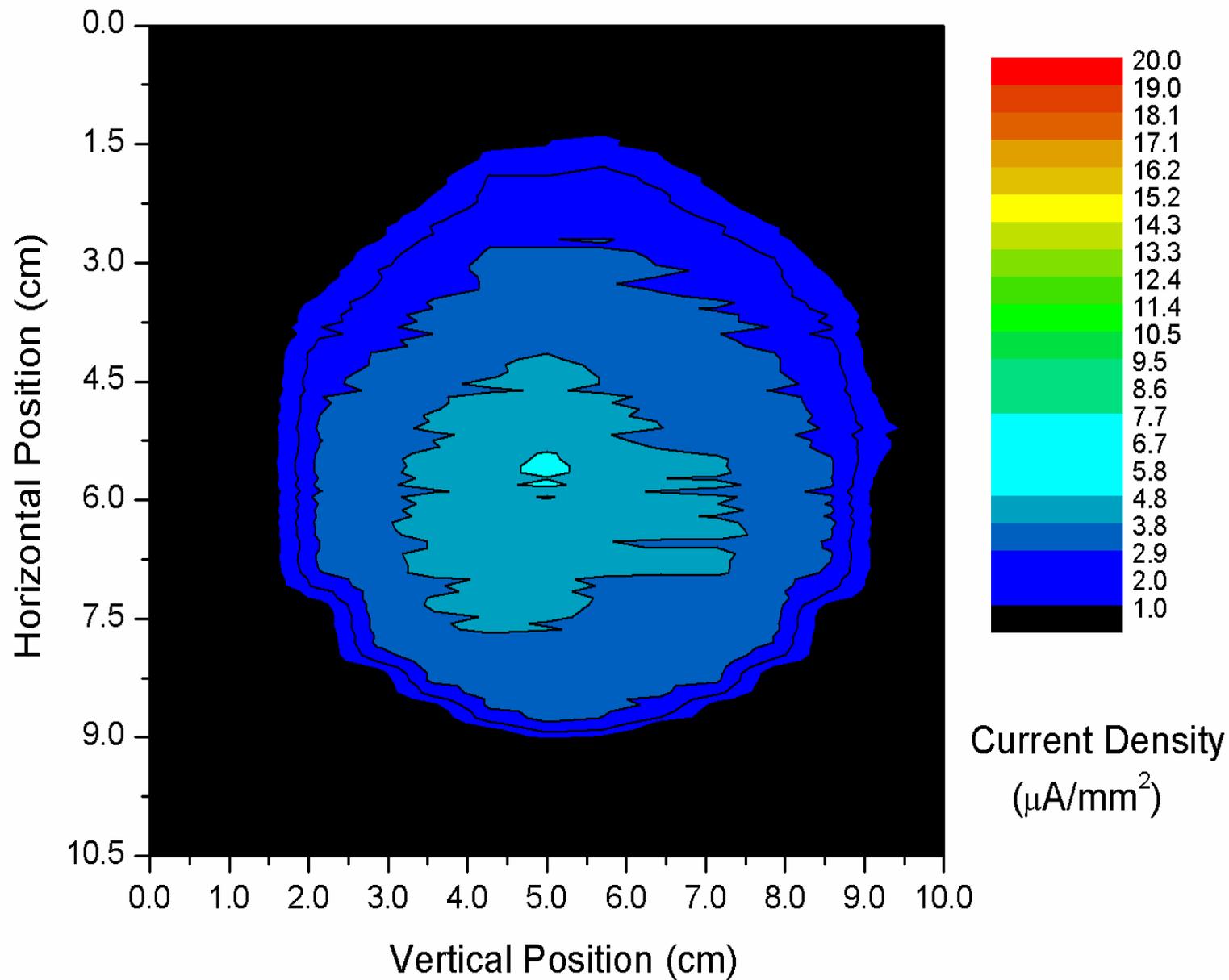


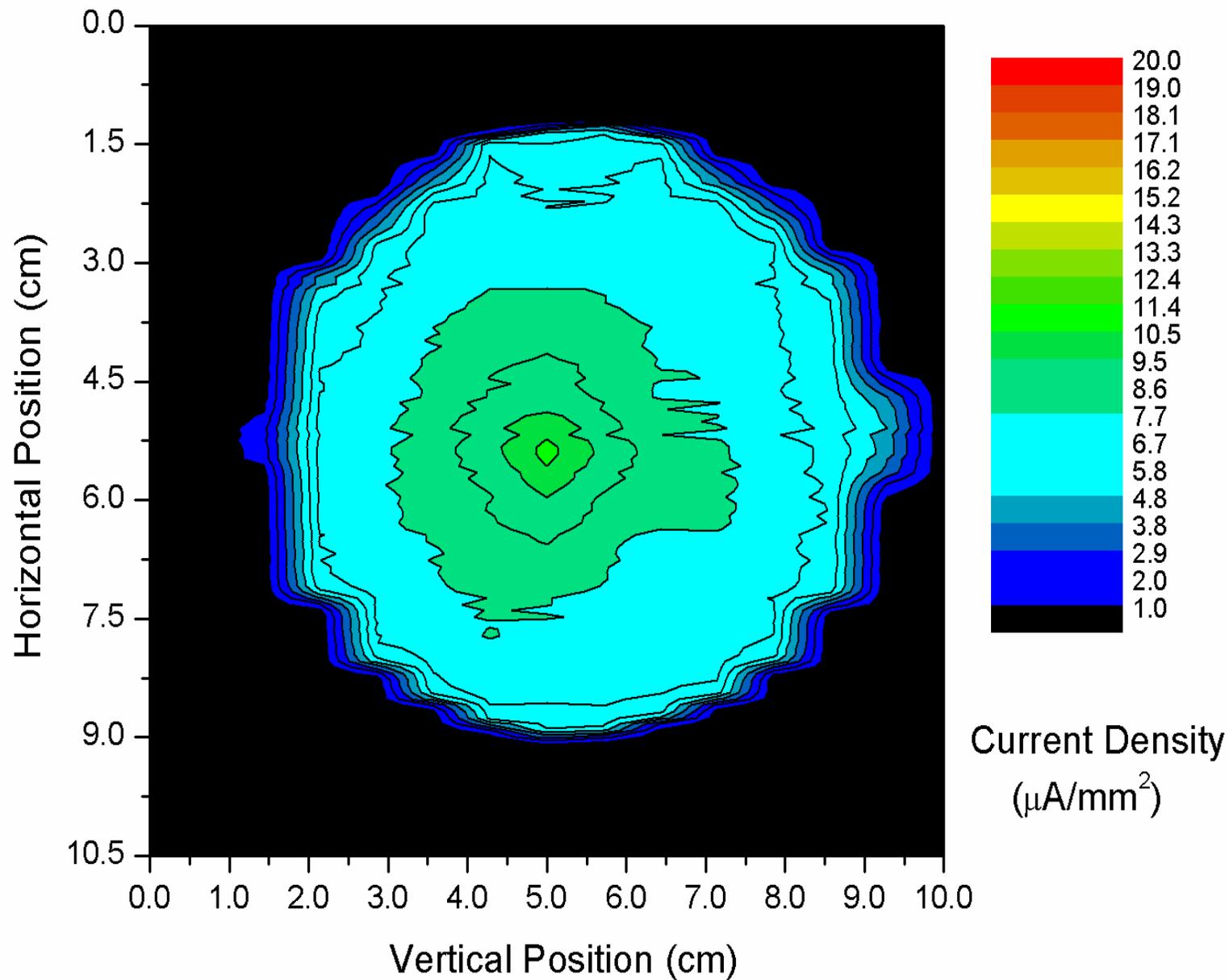
THE IMPORTANCE OF THE PEAK CURRENT DENSITY POINT

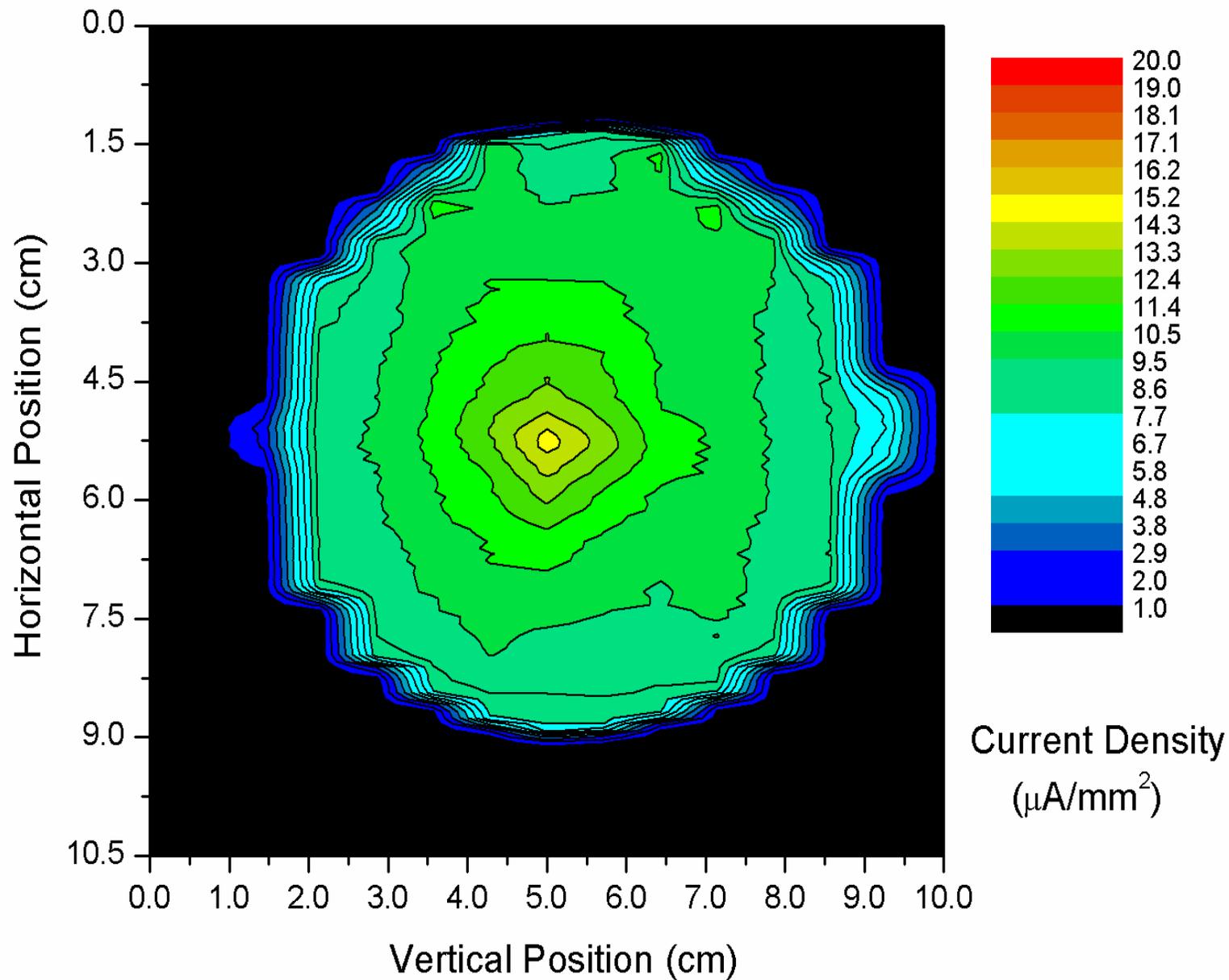
- It is desired that the highest concentration of ions is close to the center of the beam.
- Movement of the peak current density may result in ions losses.

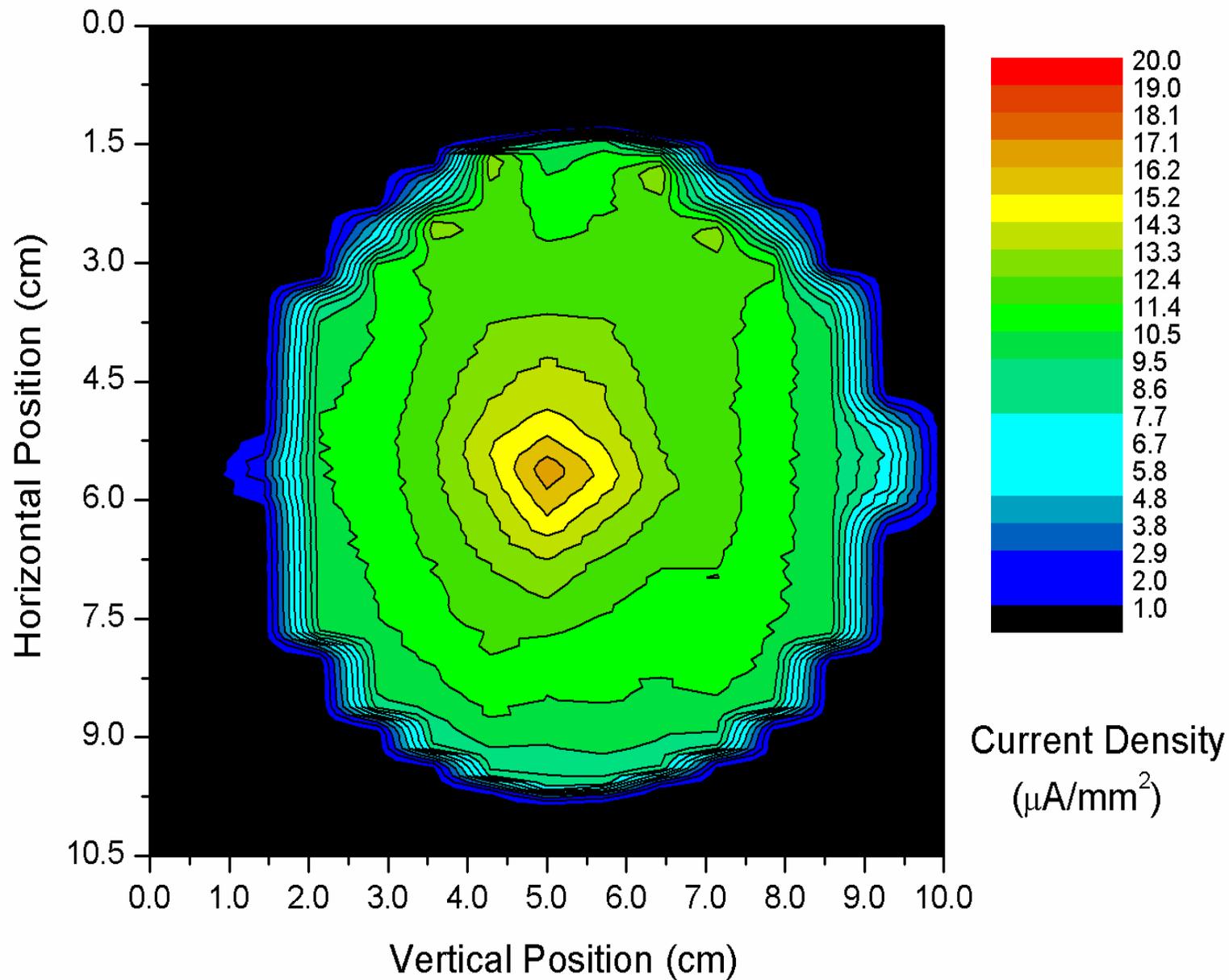


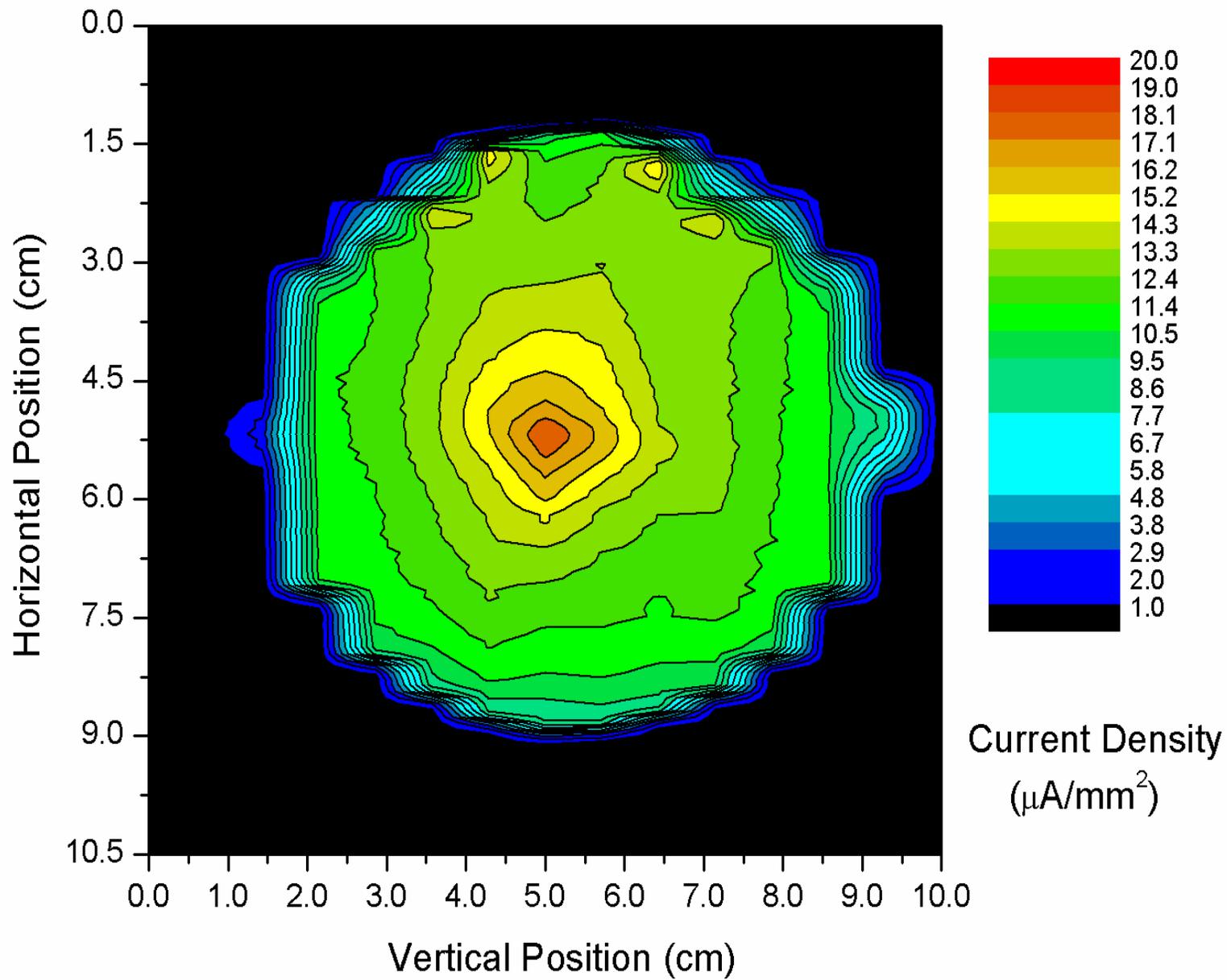


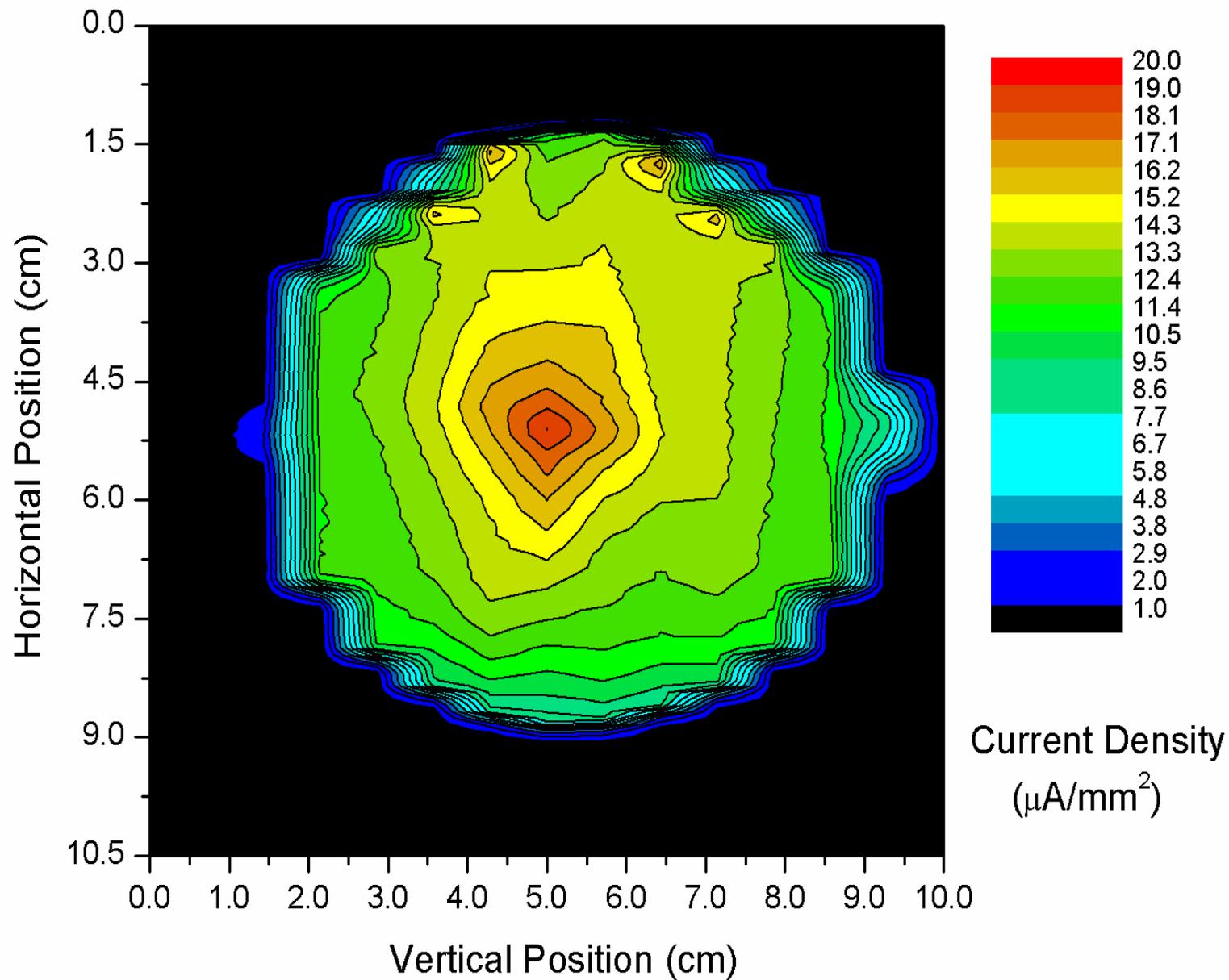


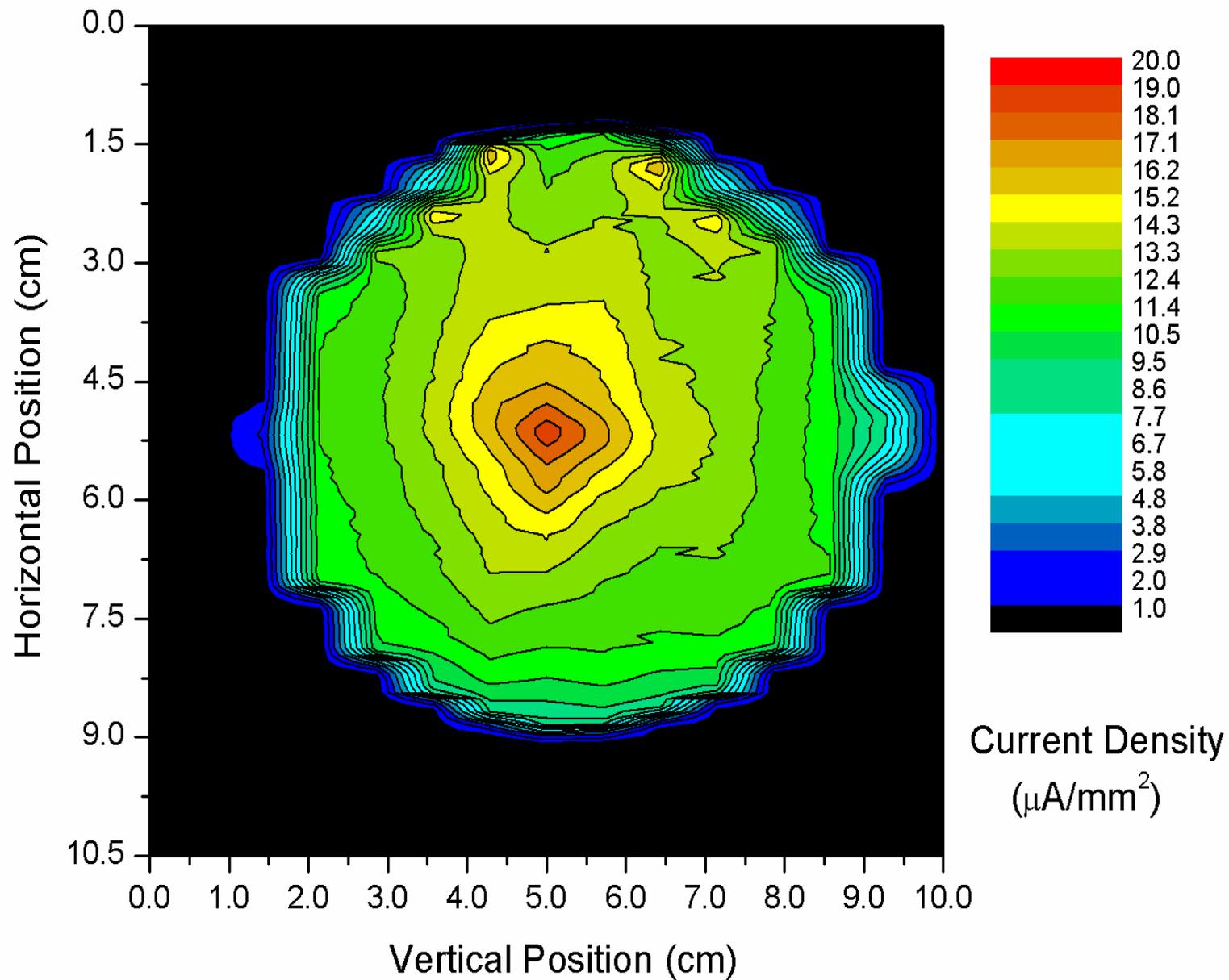


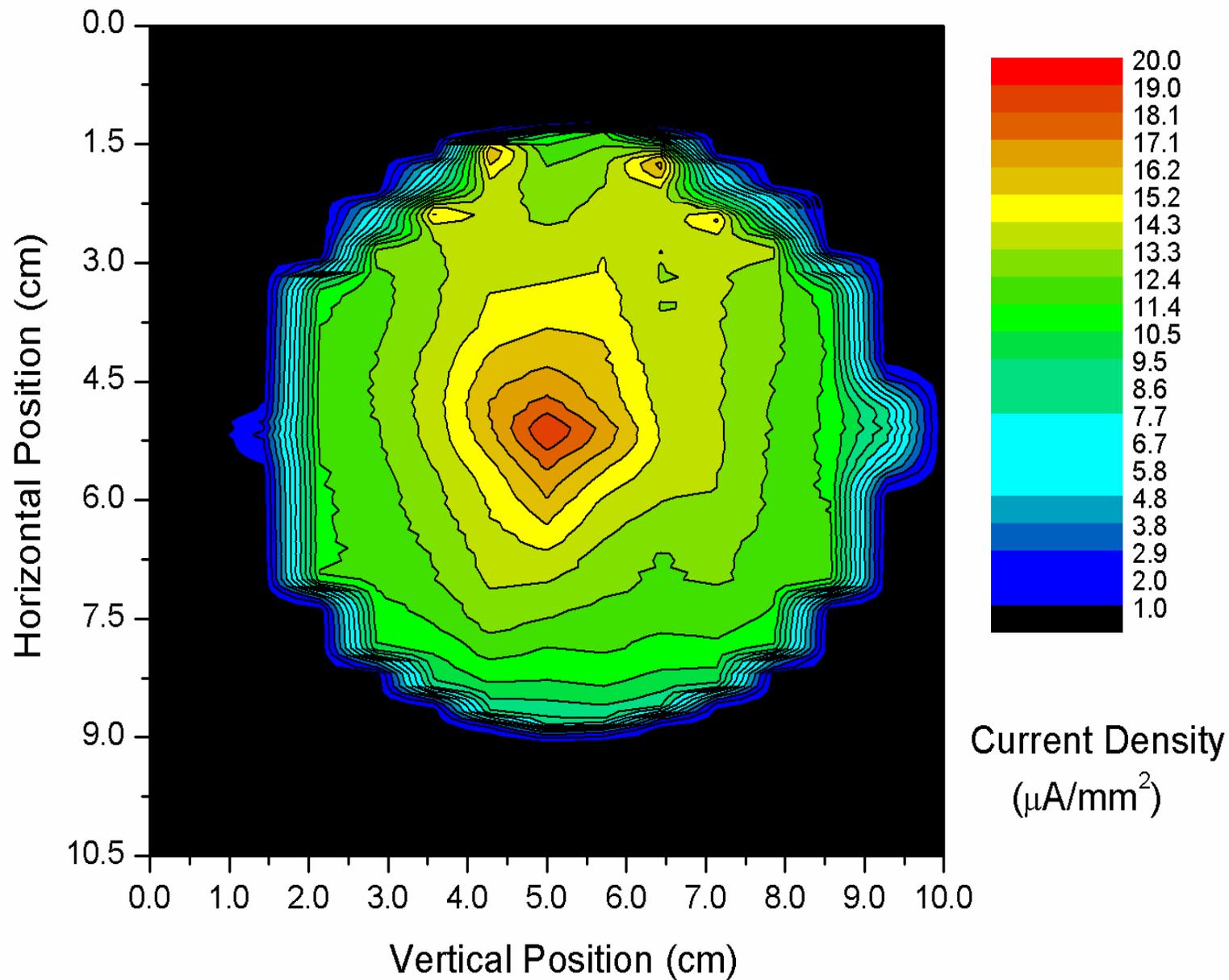


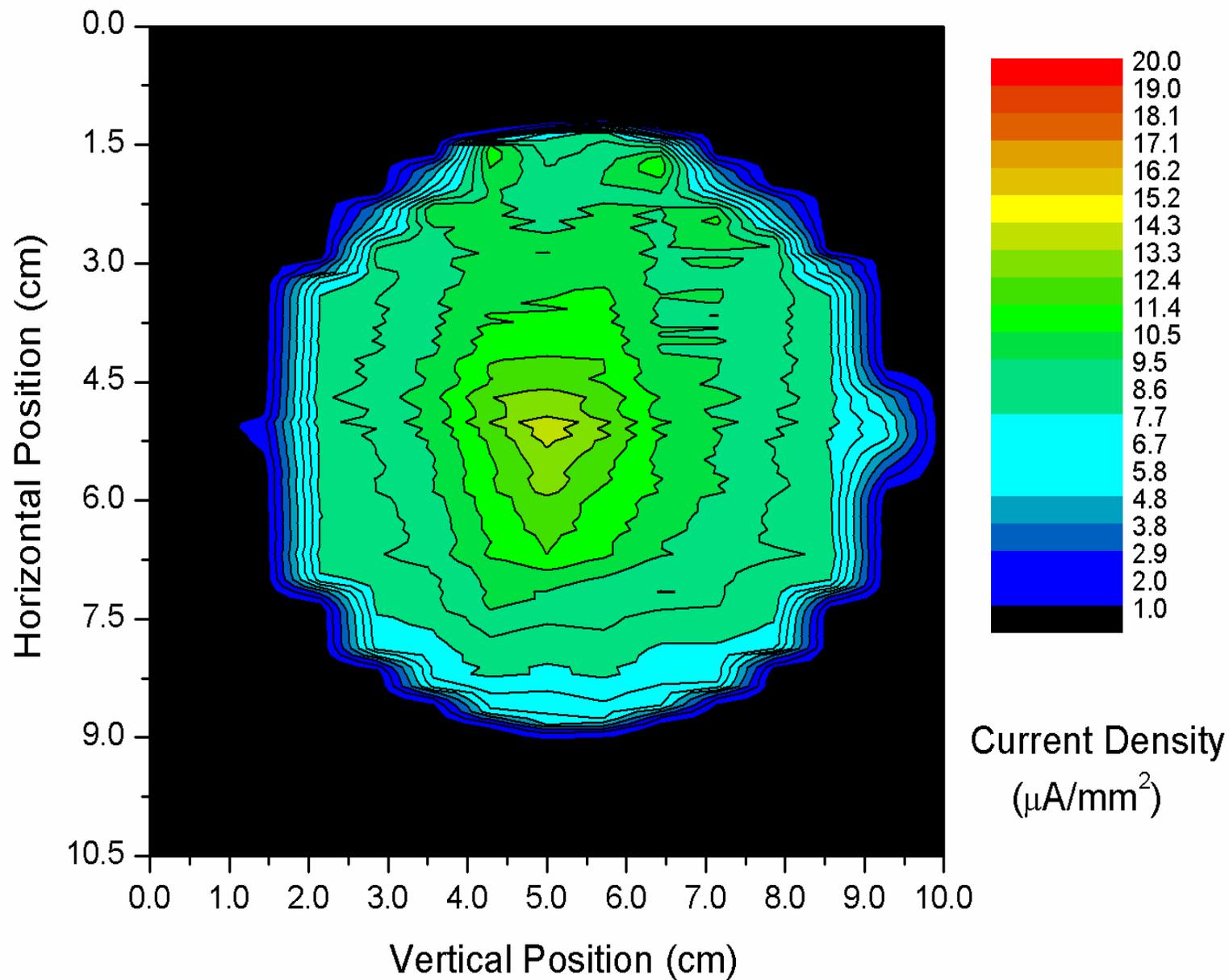


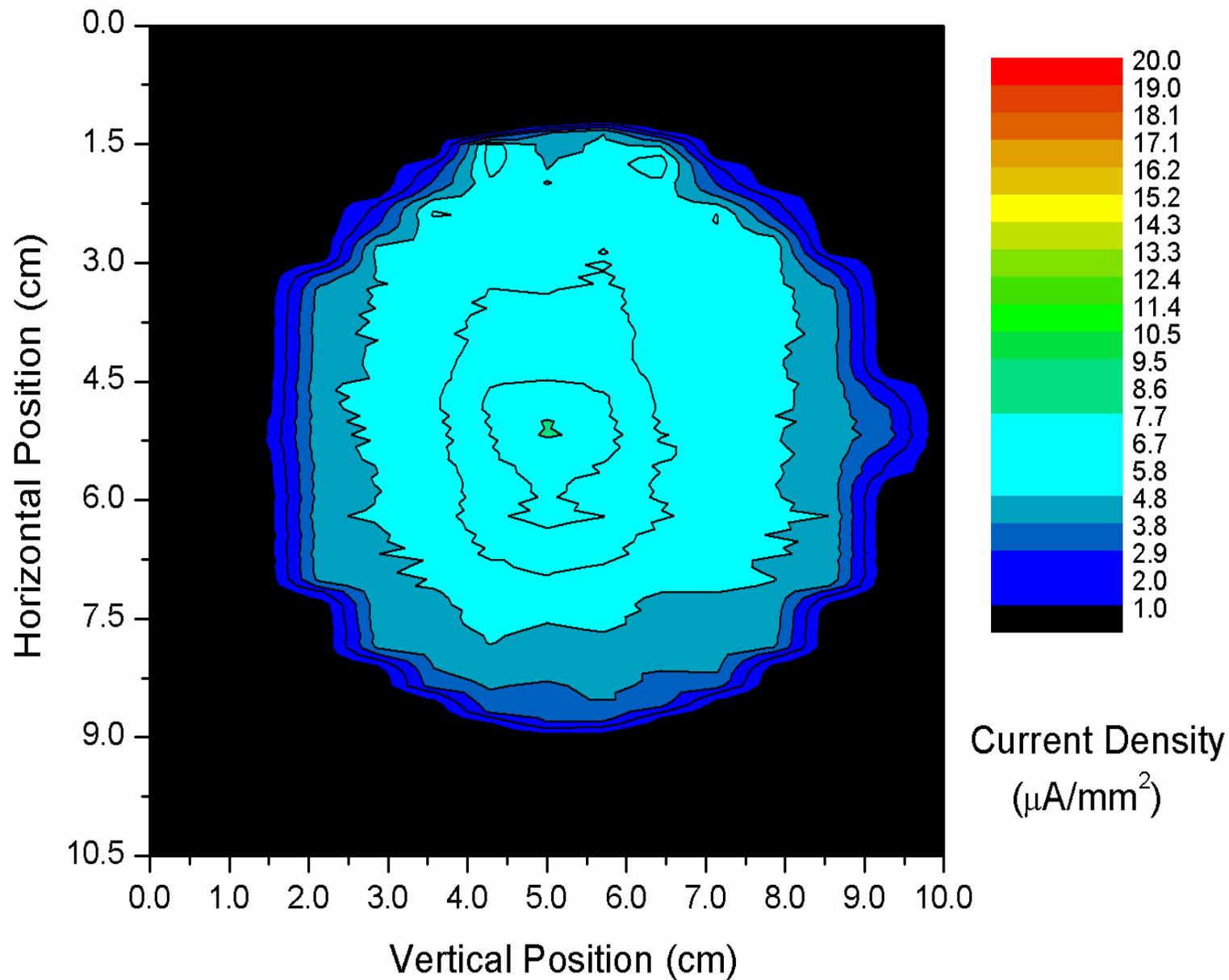


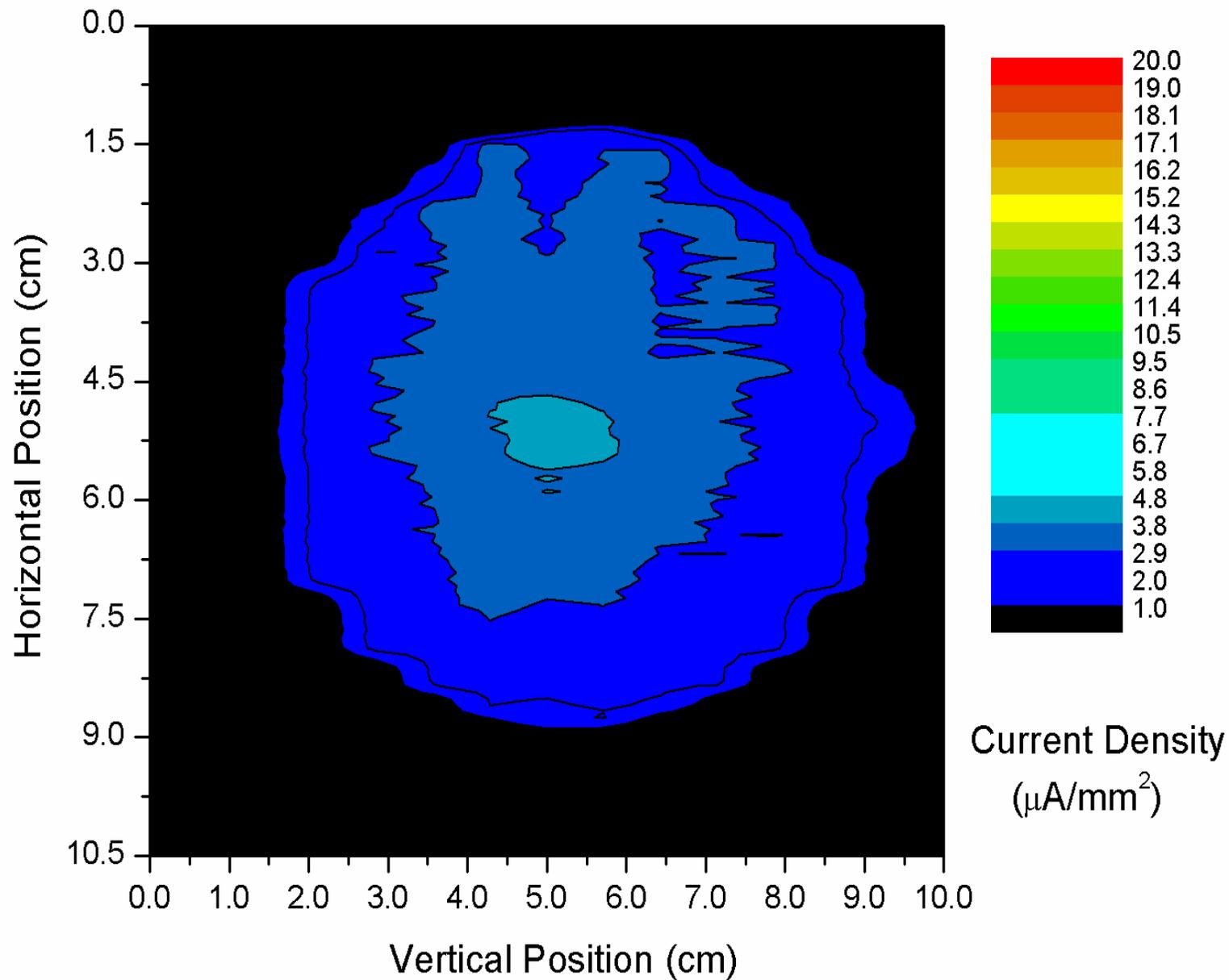


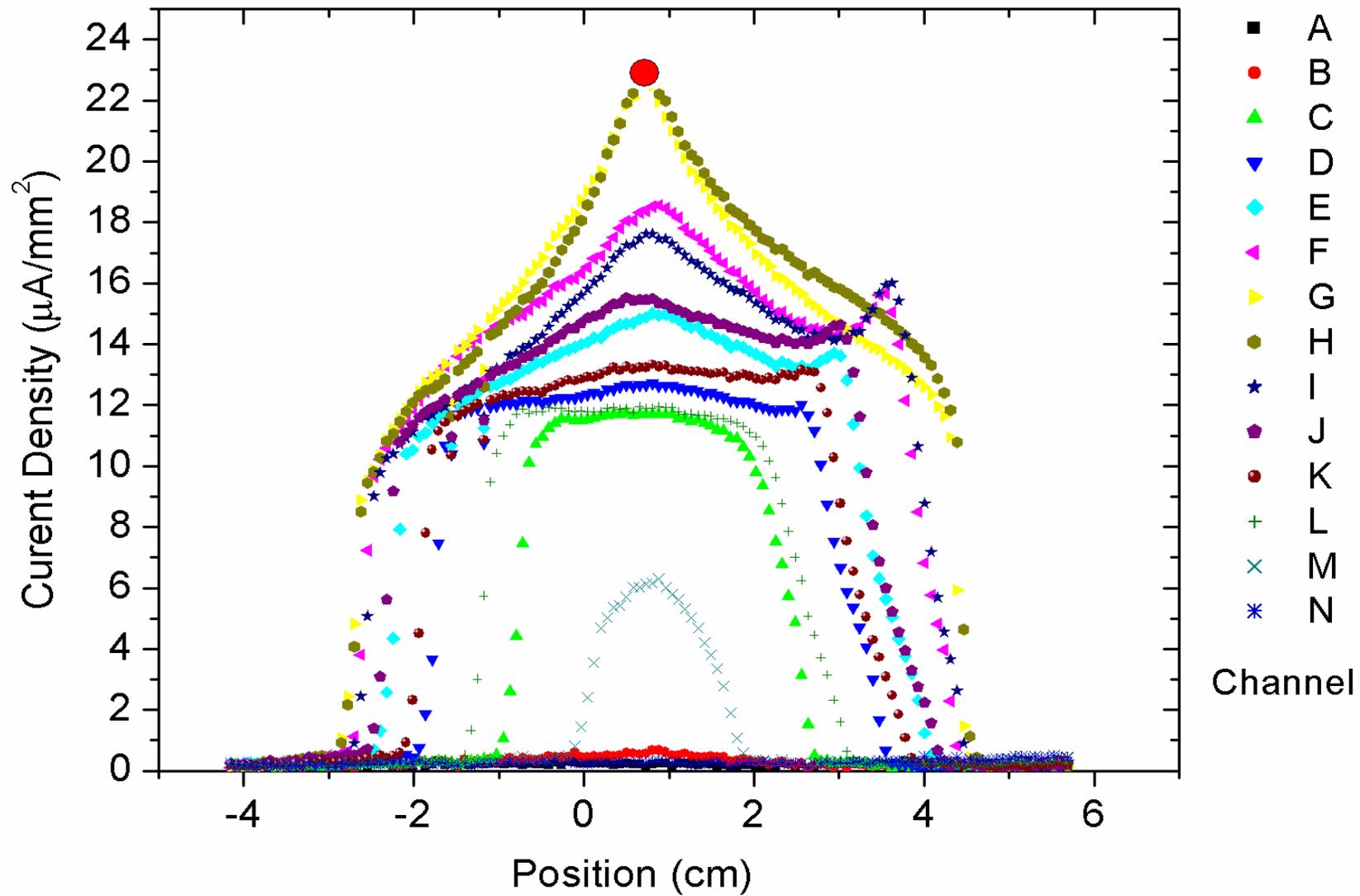


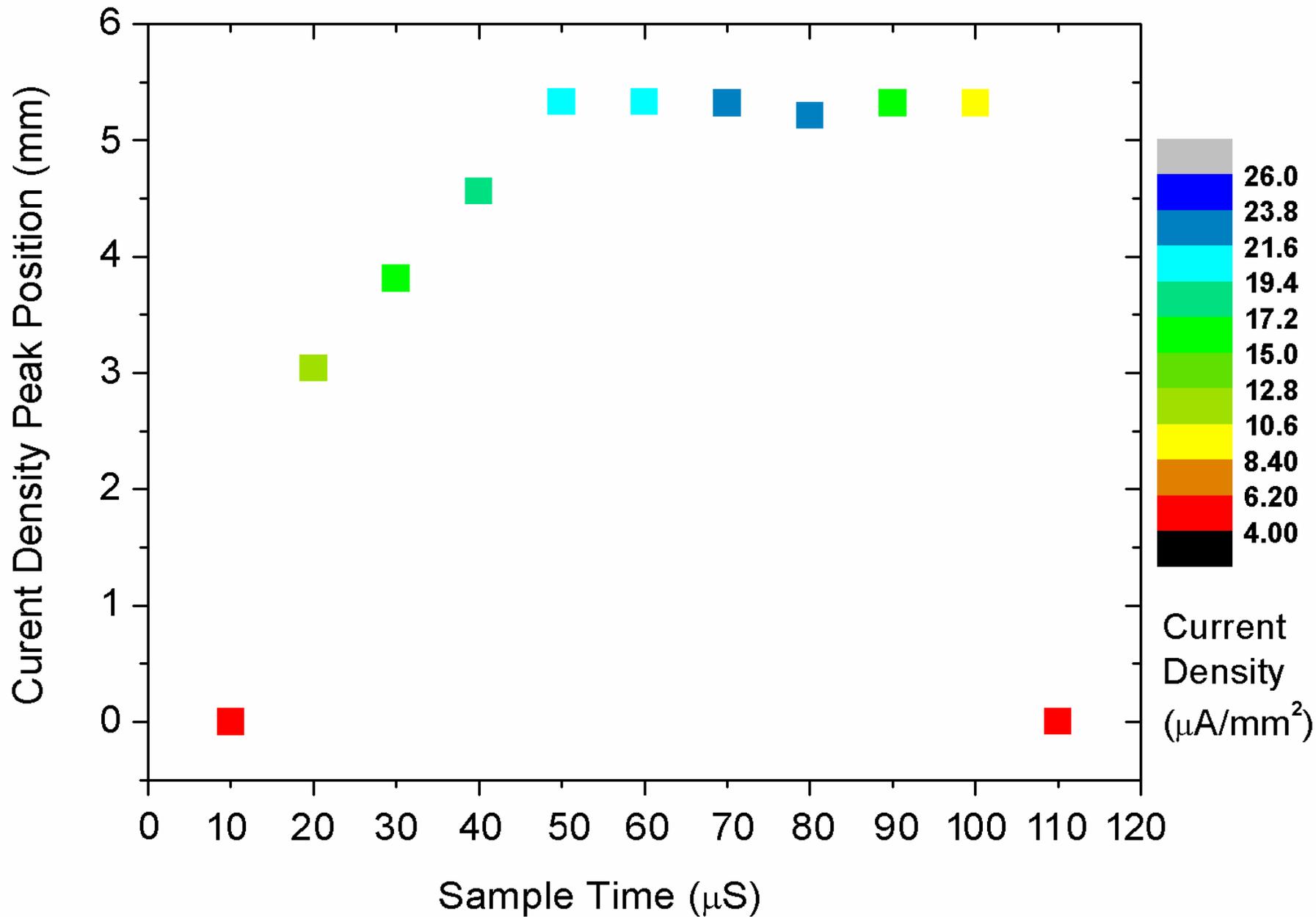


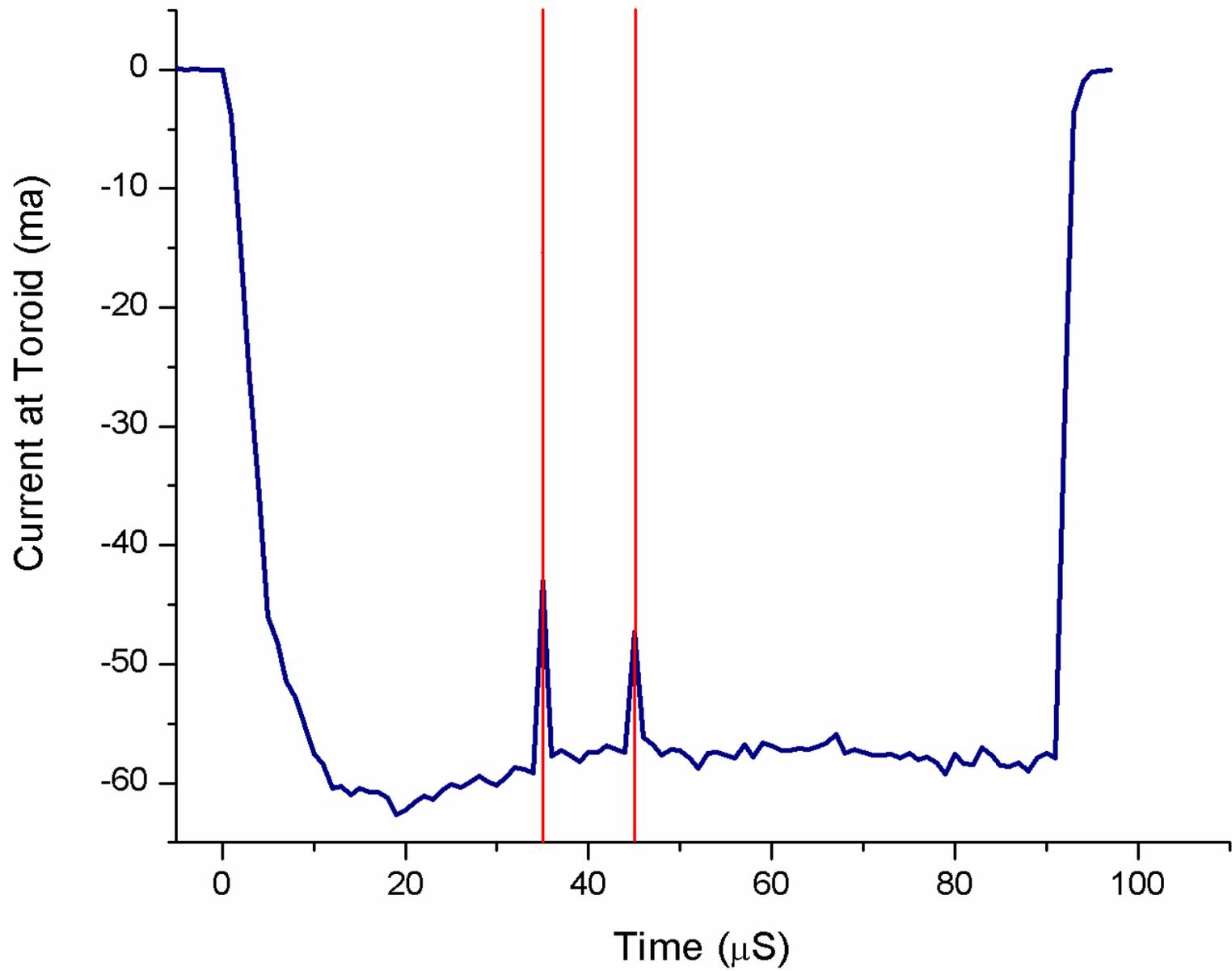


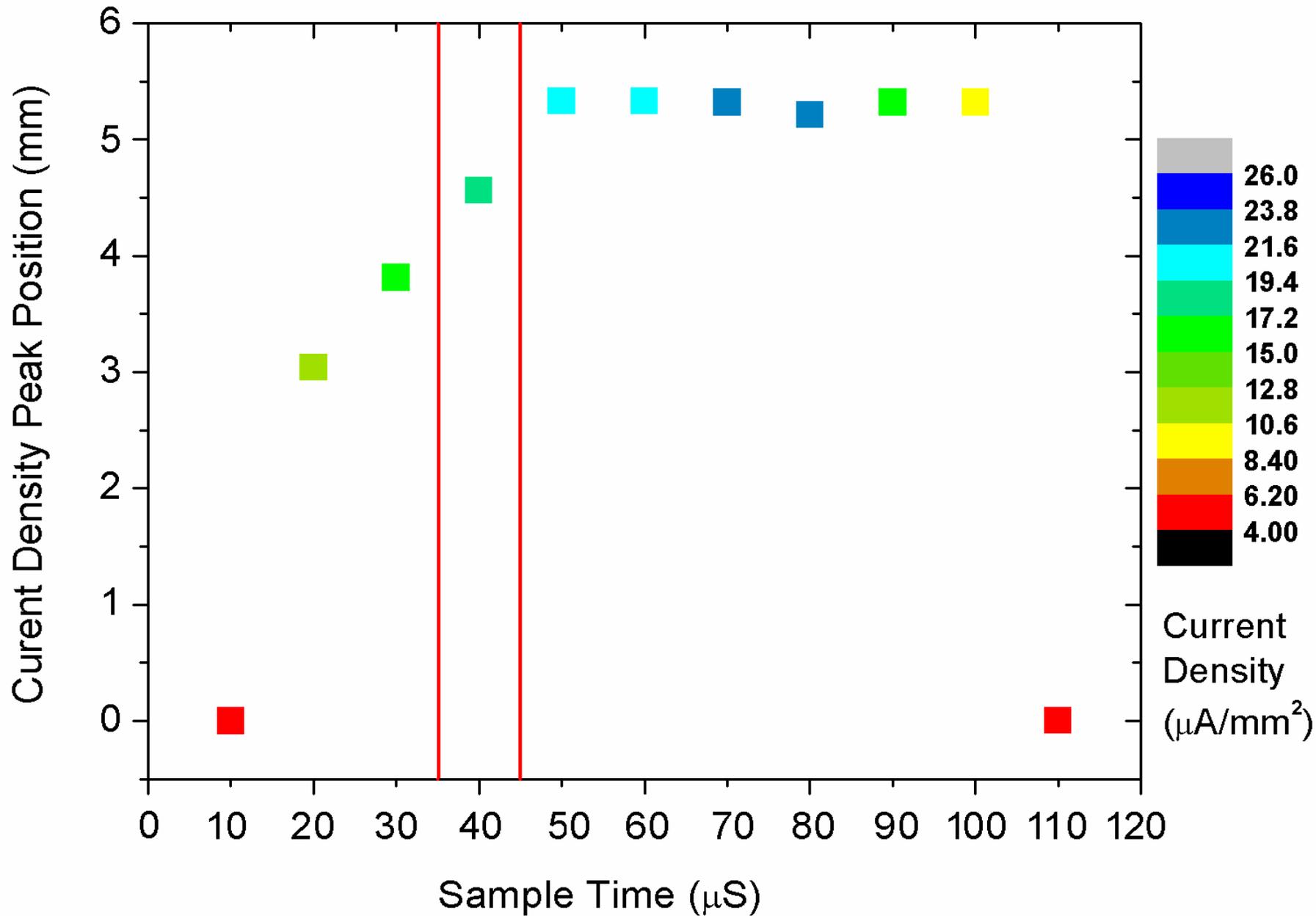












Delaying the beam pulse 25-35 μ s may:

- Improve current density.
 - Facilitate tuning.
 - Reduce beam losses.
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Acknowledgments

