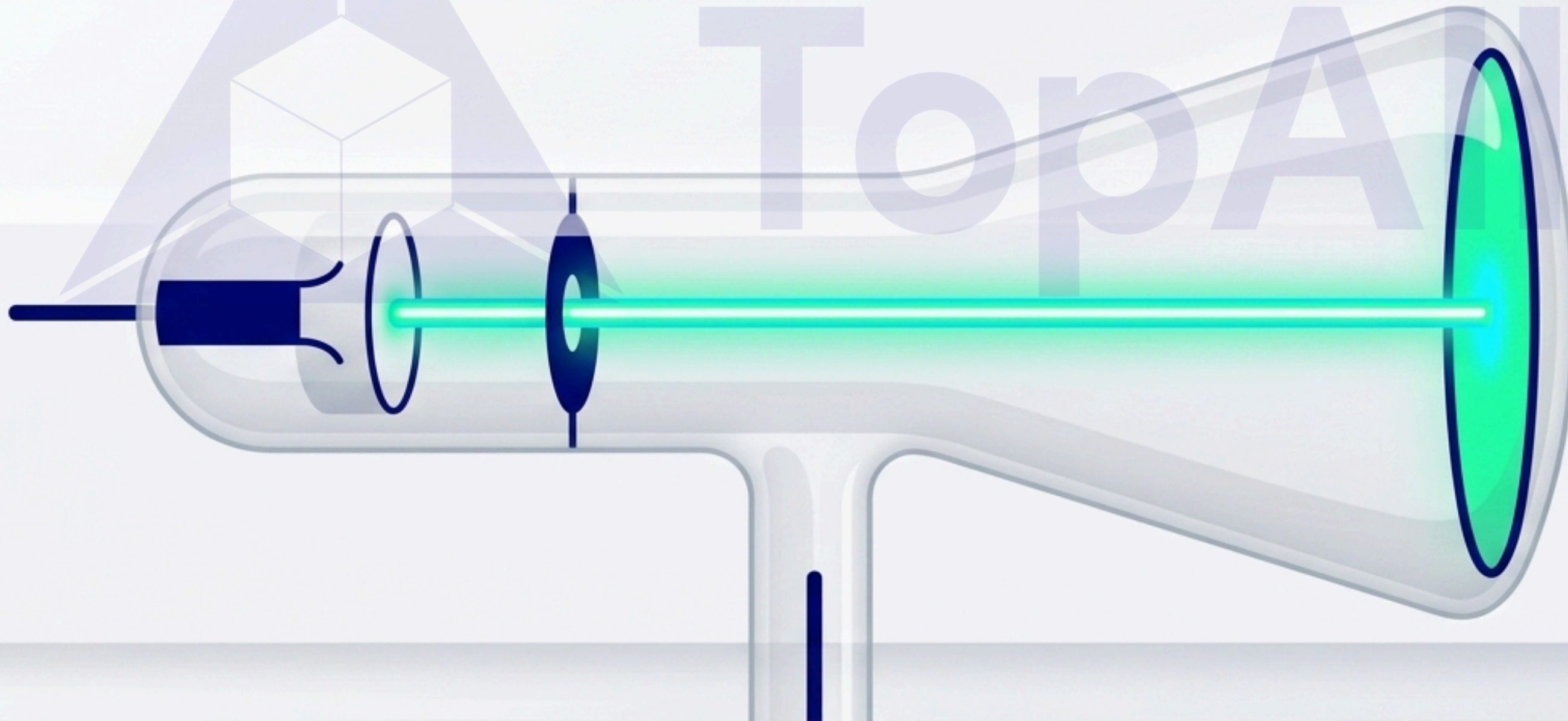


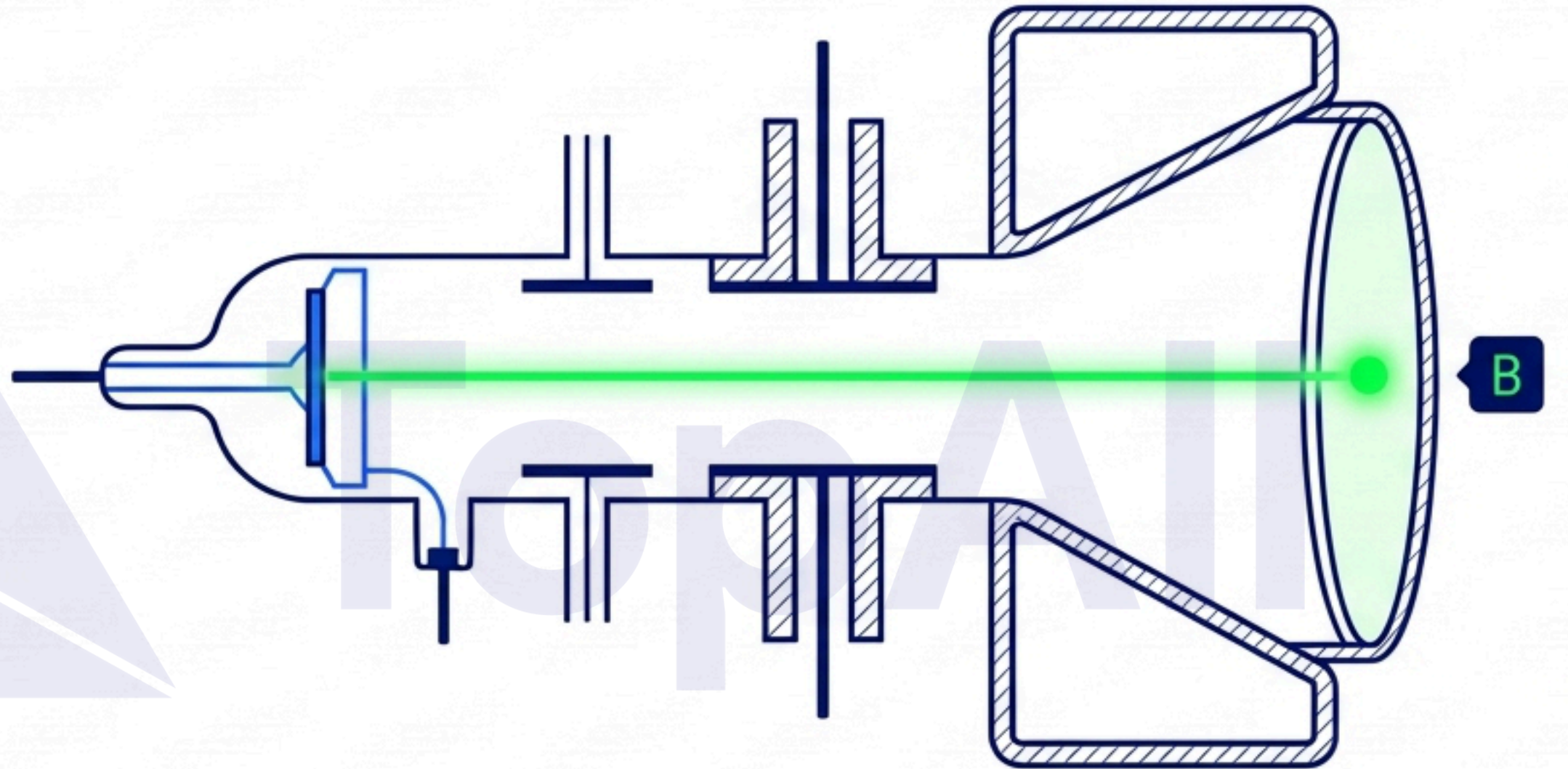
2.1.2 Charge to Mass Ratio of Electron



Beyond the Cathode Ray

Electrons were known to be the basic, negatively charged constituents of all atoms.

Thomson's goal was to measure them.

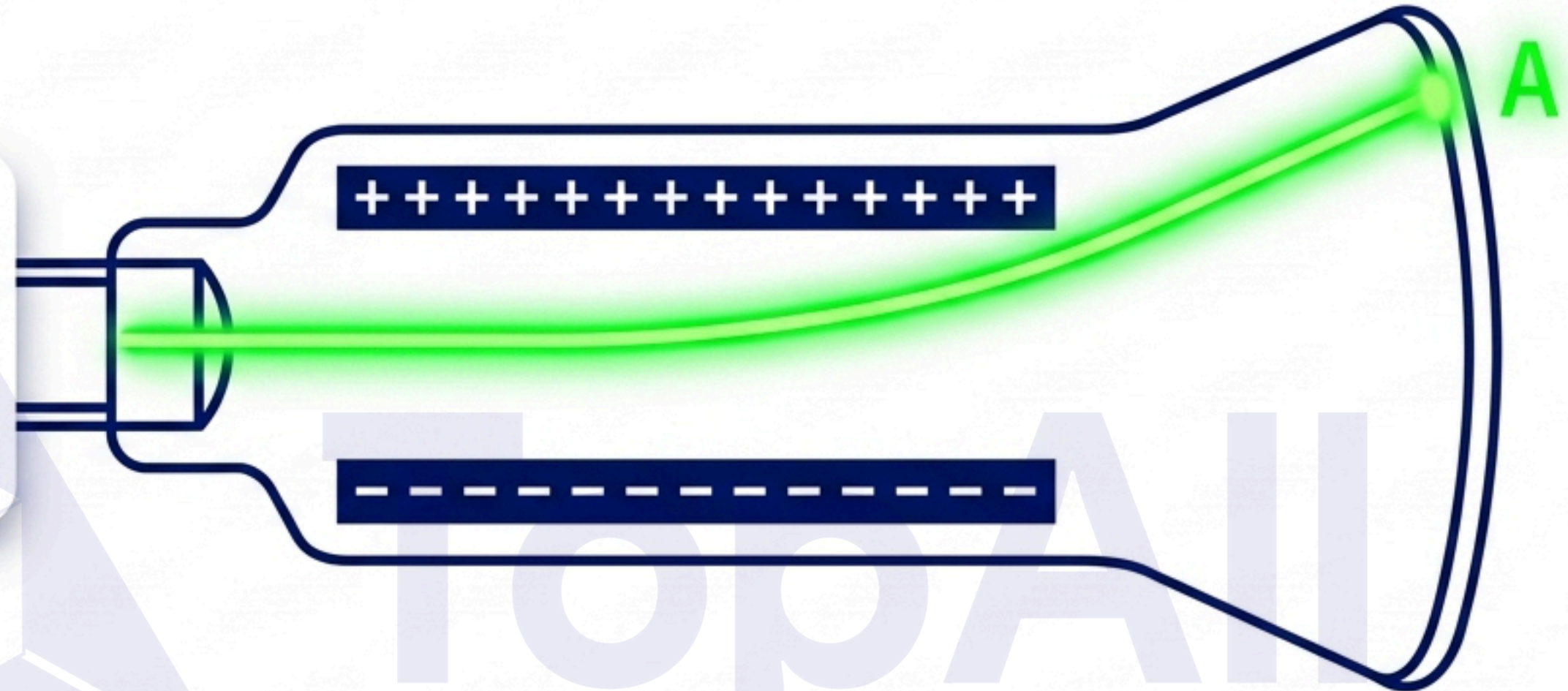


Key-Takeaway: By applying perpendicular electric and magnetic fields, Thomson could manipulate the beam's path to calculate the mysterious particle's physical properties.

Variable 1: Deflection in an Electric Field

Opposites Attract

The negatively charged electrons deviate toward the positive plate.



Variable Chip Matrix

1

Magnitude of Charge

(Greater charge = greater interaction with field = higher deflection)

2

Mass of Particle

(Lighter particle = greater deflection)

3

Strength of Field

(Higher voltage = greater deflection)



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Let's Test Them Now.**

$$E=mc^2$$



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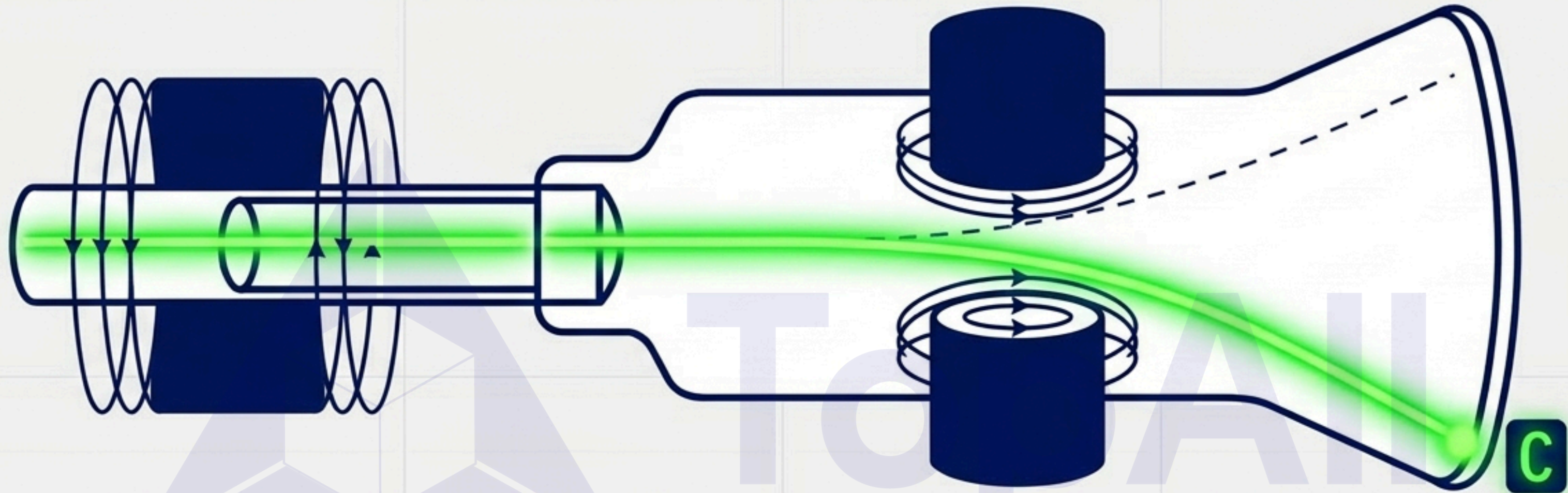
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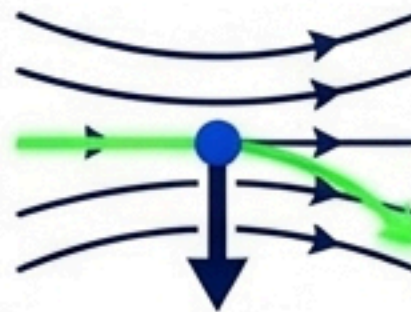


Variable 2: Deflection in a Magnetic Field



Magnetic Force

A magnetic field applied perpendicular to the electron's path pushes the moving charged particles downward, exactly opposite to the electric field's pull.



Path Comparison



Electric
Field Path

- Up to Point A



Magnetic
Field Path

- Down to Point C

Synthesis: Balancing Fields to Measure e/m_e



$$\frac{e}{m_e} = 1.758820 \times 10^{11} \text{ C kg}^{-1}$$

By accurately measuring the exact electric and magnetic field strengths required to 'zero out' the deflection and return the beam to Point B, Thomson isolated the ratio of the electron's charge (e) to its mass (m_e).

What Does 10^{11} Imply?

$$1.758820 \times 10^{11}$$

This is an astronomically large ratio.

- Option 1: The electron has an incomprehensibly huge charge.

- Option 2: The electron has an incredibly tiny mass.

The Next Step (Millikan's Oil Drop)

This massive ratio proved atoms contain subatomic particles. Later, R.A. Millikan would prove it was the mass that was tiny, using Thomson's ratio to calculate the electron's exact mass: $m_e = 9.1094 \times 10^{-31}$ kg.



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