Electron Beam Deflection Parameters

electron charge, mass and energy: e, m, K

deflector length, separation and voltage: l, d, V

deflection angle: φ

Find the deflection angle as a function of voltage

$$\varphi = \varphi(V)$$

The deflection angle φ is determined by the final velocity components

$$\tan\varphi = \left(\frac{v_y}{v_x}\right), \qquad \rightarrow \qquad \varphi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$

v_x is related to the initial kinetic energy

$$K = \frac{mv_x^2}{2}, \qquad \rightarrow \qquad v_x = \sqrt{\frac{2K}{m}}$$

Field strength E and acceleration a

$$E = \frac{V}{d}, \qquad a = \frac{eE}{m}$$

Find v_y from flight time t

$$v_y = at, \qquad t = \frac{l}{v_x}, \quad \rightarrow \quad v_y = \frac{leV}{mdv_x}$$

Expressing φ in terms of the parameters

$$\varphi = \tan^{-1}\left(\frac{leV}{mdv_x{}^2}\right) = \tan^{-1}\left(\frac{l}{2d}\frac{eV}{K}\right)$$

Example: Suppose

$$K = 100\ keV = 10^5\ eV = 1.6 \times 10^{-14}\ J$$

$$l = 0.01m, \qquad d = 0.001m, \qquad V = 100V$$

$$\varphi = \tan^{-1}\left(\frac{l}{2d}\frac{eV}{K}\right) = 5.0 \times 10^{-3}\ rad = 0.29°$$