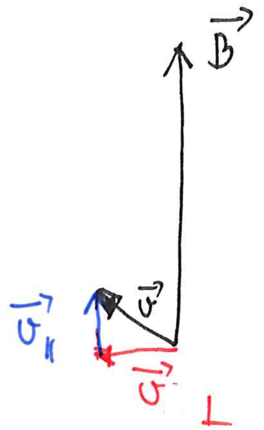
Charges on Helical Paths



$$\vec{V} = \vec{V}_{\perp} + \vec{V}_{\parallel}$$

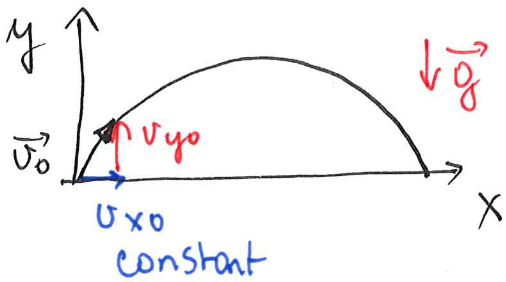
$$\vec{F}_B = q\,\vec{V} \times \vec{B}$$

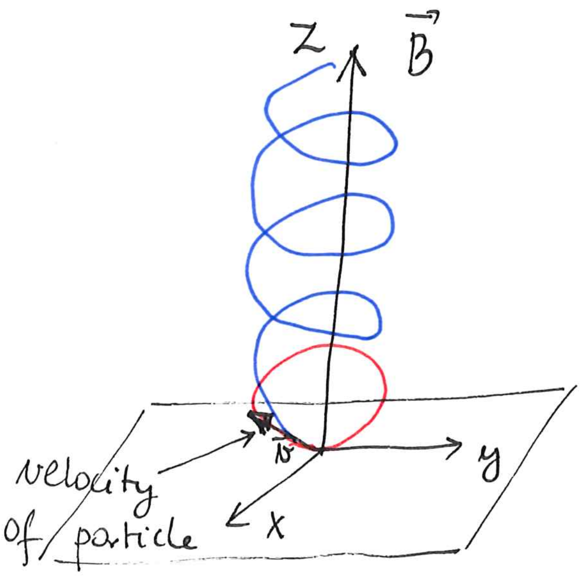
$$\vec{F}_B = q\,(\vec{V}_{\perp} + \vec{V}_{\parallel}) \times \vec{B}$$

$$= \underbrace{q\,\vec{V}_{\perp} \times \vec{B}}_{\vec{F}_B} + \underbrace{q\,\vec{V}_{\parallel} \times \vec{B}}_{0}$$

$\vec{F}_B$ acts as centripetal force → circular motion

0: motion with constant velocity





$$\vec{F}_B = q\,\vec{V}_{\perp} \times \vec{B}$$

never in z-direction

means: $\vec{V}_{\parallel}$ is constant

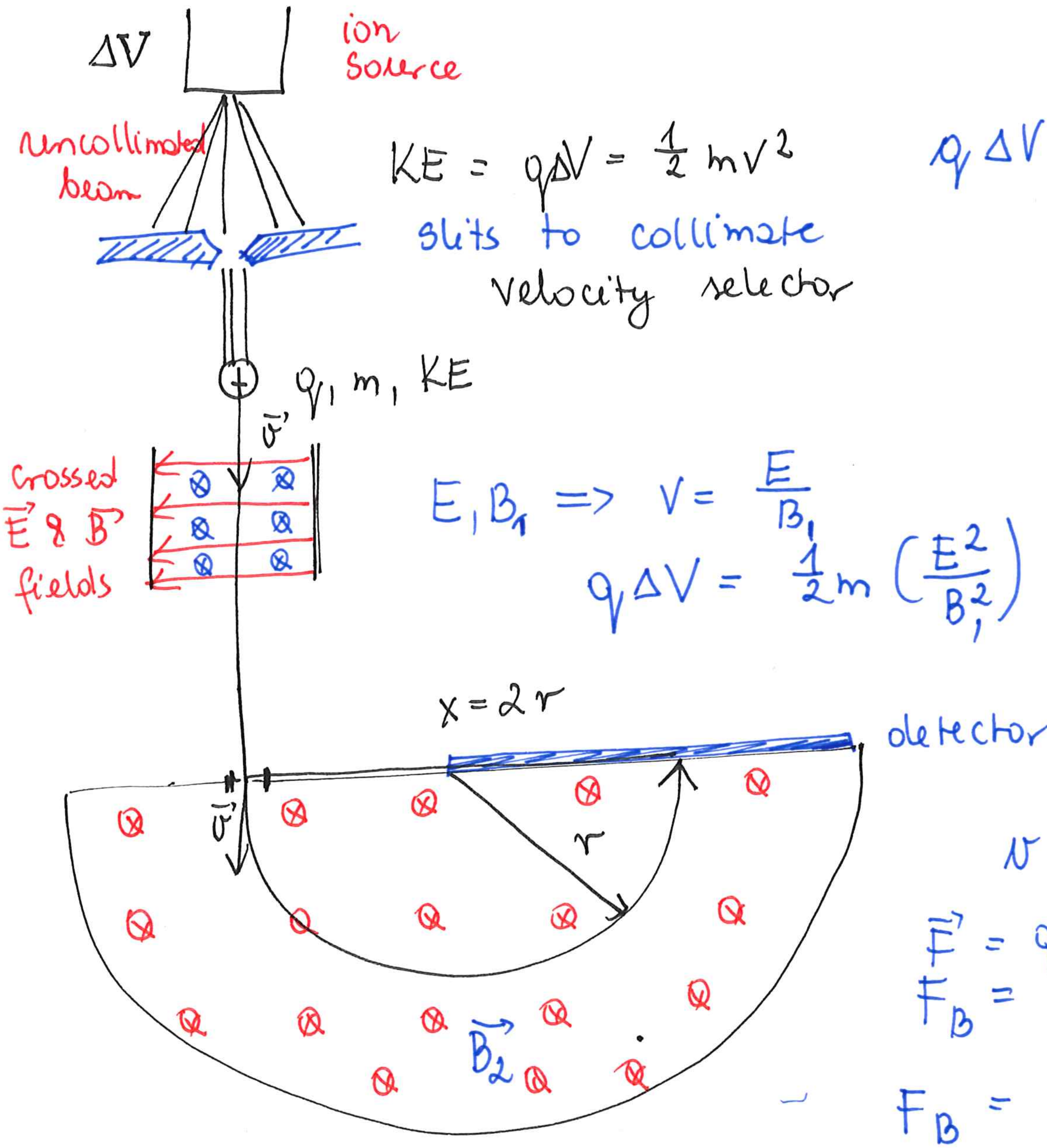
↳ only in z direction

↑ steady velocity upward (z)

\+

○ circular motion in x, y plane

Details of mass spectrometer



$$KE = q\Delta V = \frac{1}{2} m v^2$$

$$q\Delta V = \frac{1}{2} m v^2$$

$$E, B_1 \Rightarrow v = \frac{E}{B_1}$$

$$q\Delta V = \frac{1}{2} m \left(\frac{E^2}{B_1^2}\right)$$

$$v = \frac{E}{B_1}$$

$$\vec{F} = q\vec{v} \times \vec{B} \qquad \vec{v} \perp \vec{B}$$

$$F_B = q v B_2$$

$$F_B = q \frac{E}{B_1} B_2$$

$$F_c = \frac{m v^2}{r} = \frac{m\left(\frac{E^2}{B_1^2}\right)}{\frac{x}{2}}$$

$$F_c = \frac{m E^2 2}{B_1^2 x}$$

$$F_B = F_c$$

$$q \frac{\cancel{E}}{\cancel{B_1}} B_2 = \frac{m E^{\cancel{2}} 2}{B_1^{\cancel{2}} \cdot x}$$

$$m = \frac{q B_1 B_2 x}{2E}$$