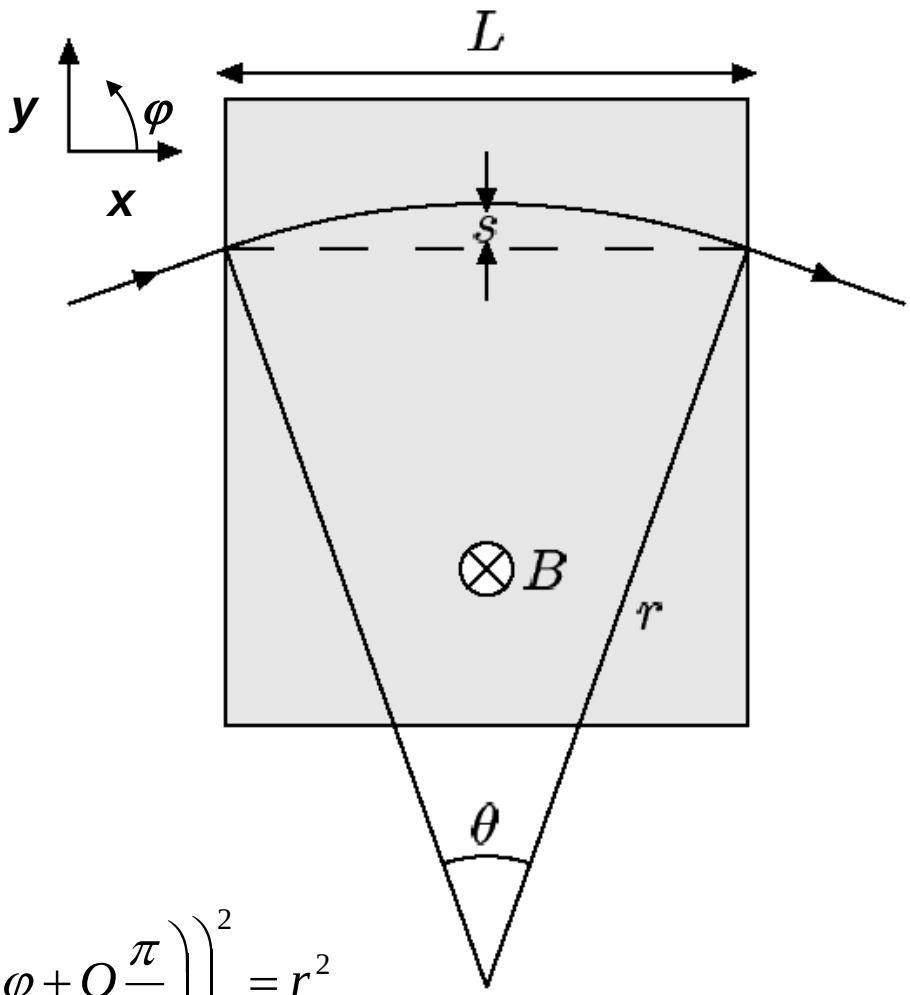
A simple model of the ATLAS Upgrade tracker

- **Assume all particles originate from the origin (x,y)=(0,0) with a given momentum traveling in a randomly chosen direction**

- **Assume that on their way particles encounter**
  - **the wall of a Berilium beam pipe (r = 35mm, thickness = 3 mm)**
  - **Silicon detector layer 1 (r = 45 mm, thickness = 0.5 mm)**
  - **Silicon detector layer 2 (r = 80 mm , thickness = 0.5 mm)**
  - **Silicon detector layer 3 (r = 120 mm , thickness = 0.5 mm)**
  - **Silicon detector layer 4 (r = 180 mm , thickness = 0.5 mm)**
  - **Silicon detector layer 5 (r = 300 mm , thickness = 0.5 mm)**
  - **Silicon detector layer 6 (r = 400 mm , thickness = 0.5 mm)**
  - **Silicon detector layer 7 (r = 500 mm , thickness = 0.5 mm)**
  - **Silicon detector layer 8 (r = 700 mm , thickness = 0.5 mm)**
  - **Silicon trigger layer 9A (r = 900 mm , thickness = 0.5 mm)**
  - **Silicon trigger layer 9B (r = 910 mm , thickness = 0.5 mm)**
- **The particles always travel in a B-field of 4 T pointing along the z-direction.**

Charged particle in a magnetic field

Magnetic force : $\vec{F} = q\left(\vec{v} \times \vec{B}\right)$ or $|F| = qv_{\perp}B$



Centrifugal force : $|F| = \dfrac{mv_{\perp}^2}{r}$

Radius : $r = \dfrac{mv_{\perp}}{qB} = \dfrac{P_{\perp}}{qB}$,

or $r = \dfrac{P_{\perp}}{0.3B}$ ($P_{\perp}$ in GeV/c and B in Tesla)

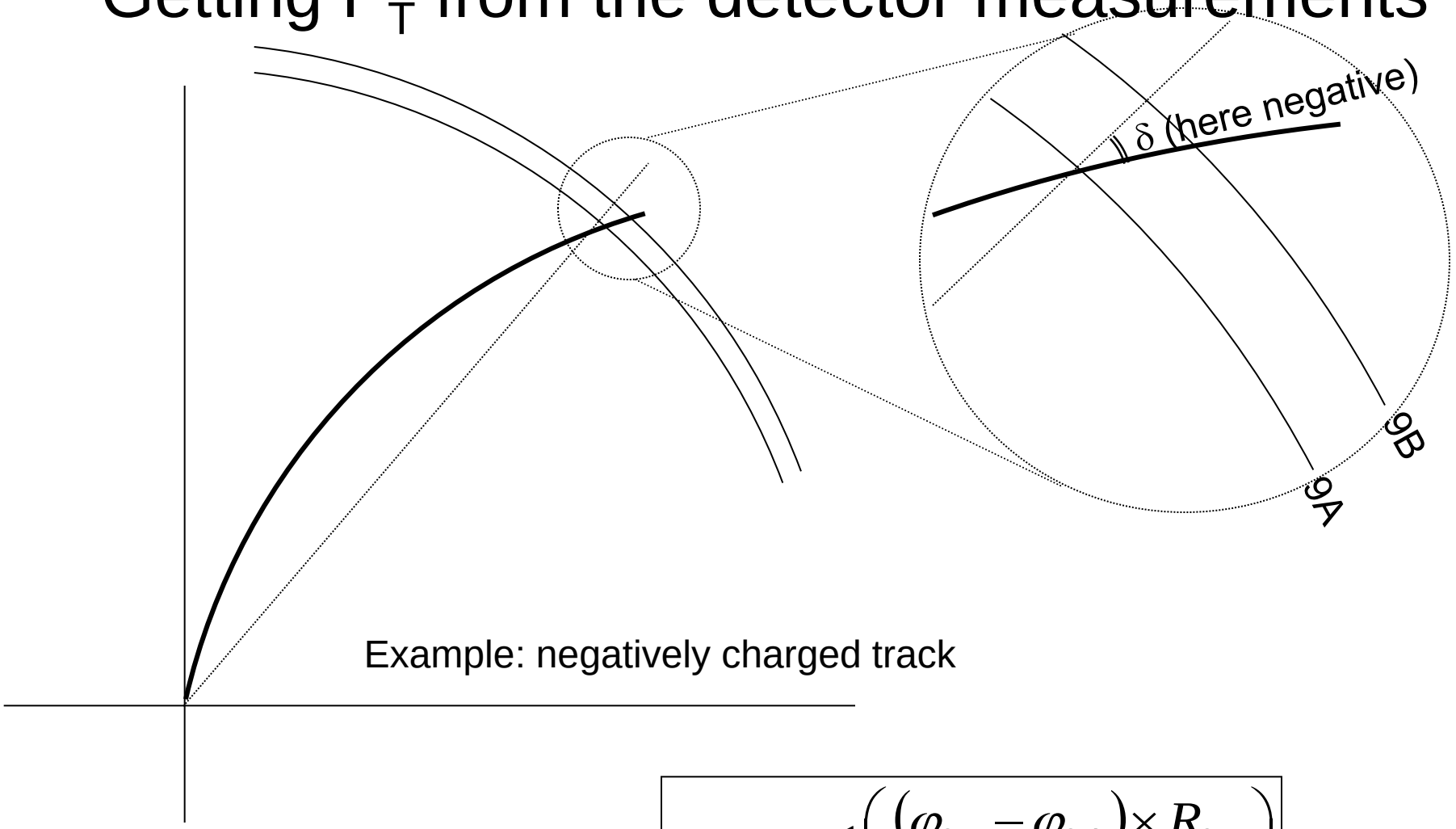
Then a particle starting at (x_0, y_0)

will describe the trajectory :

$$\left(x - x_0 - |r|\sin\left(\varphi + Q\frac{\pi}{2}\right)\right)^2 + \left(y - y_0 - |r|\cos\left(\varphi + Q\frac{\pi}{2}\right)\right)^2 = r^2$$

where $Q = \pm 1$ and $\varphi = \tan^{-1}\left(\dfrac{P_y}{P_x}\right)$

Getting P_T from the detector measurements



Example: negatively charged track

You've measured the phi angles in the two trigger layers.

$$\delta \approx \tan^{-1}\left(\frac{(\varphi_{9B} - \varphi_{9A}) \times R_{9B}}{R_{9B} - R_{9A}}\right)$$

$$P_{\perp} \approx \frac{0.3BR}{2\delta}$$

B-field direction: $\otimes$ (into paper)