Measurement of momentum for charged particles

Detector Basic 18/07/18

M2 Yosuke Kobayashi

Measurement of momentum

- Charged particle traveling in a magnetic field is acted on Lorentz force.

$$f = q\boldsymbol{v} \times \boldsymbol{B}$$

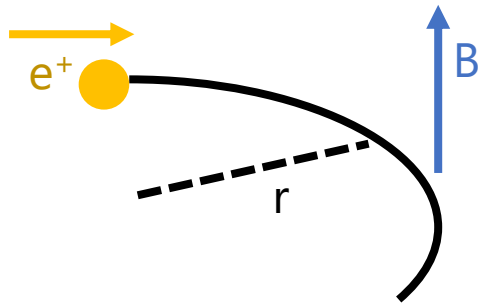
q : charge
B : magnetic field strength
v : velocity

- If the strength of the magnetic field and the radius are known, the momentum can be measured.

$$r = \frac{mv}{qB} = \frac{p}{qB}$$

m : mass of particle

$$p\ [GeV/c] = 0.3\ r[m]B[T]$$



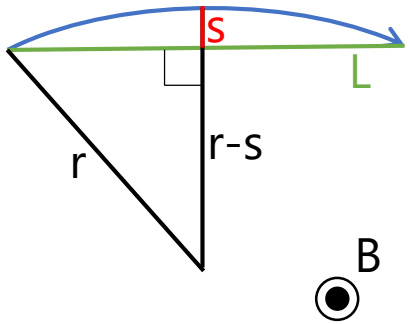
Measurement method

- Tracks are reconstructed by each detector.
  - The momentum is determined from the radius and the charge is obtained from the direction of bending.

- Track reconstruction detectors
  - Gas multiplication detector
    - Position resolution : 50 ~ 300 μm
  - Scintillation counter
    - Position resolution : Different by scintillator…
  - Semiconductor detector
    - Position resolution : Different by pixel size…

Real application

- The measured track is close a straight line in real application.
- sagitta s is calculated.



$$r^2 = (r-s)^2 + \left(\frac{L}{2}\right)^2$$

$$s = r - \sqrt{r^2 - \frac{L^2}{4}}$$

$$r = \frac{s}{2} + \frac{L^2}{8s} \approx \frac{L^2}{8s} (s \ll L)$$

The relation between radius and momentum

$$r = \frac{p}{qB} \Longrightarrow s = \frac{qBL^2}{p}$$

- Reference
  - http://summerstudents.desy.de/e69118/e177730/e202573/Detectors_Summer2015_part4.pdf

Appendix

$$p = mv = rqB \text{ [kg} \cdot \text{m/s]}$$

$$pc = rqBc \text{ [J]}$$

$$pc = \frac{rqBc}{1.6\times10^{-19}} \text{ [eV]}$$

$$pc = rBc \text{ [eV]}$$

$$pc = rB \cdot 3.0 \times 10^{8} \text{ [eV]}$$

$$p = 0.3rB \text{[GeV/c]}$$

r : radius [m]
q : charge
B : magnetic field strength [T]