Interactive Session on Data Analysis

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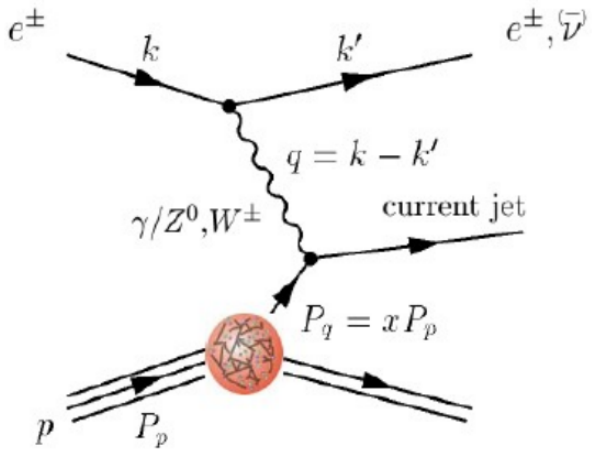
Plan

- Challenges with Experiments
- Method to extract Structure Functions
- Data Analysis along with you
- Results

Challenges with Experiments

- Beam Luminosity and Energy
- Detector Efficiency and Acceptance
- Detector Resolution
- Background Rejection
- Cross-section
- Errors : Statistical and Systematic

Deep Inelastic Scattering ($ep \rightarrow eX$)



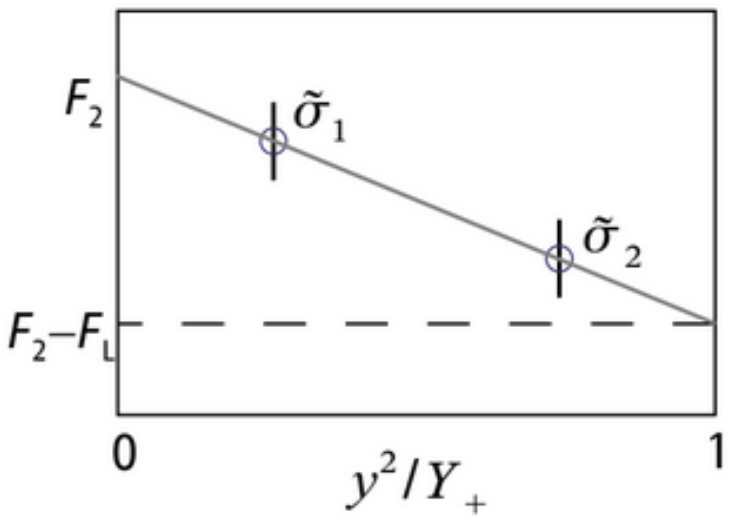
Kinematic Variables

- Centre-of-mass Energy ($\sqrt{s}$) : $s = (p + k)^2$
- Virtuality of the Photon (Q^2) : $Q^2 = -q^2 = -(k - k')^2$
- Bjorken x : $x = \frac{Q^2}{2P.q}$
- Inelasticity (y) : $y = \frac{q.P}{k.P} = 1 - \frac{E_e'}{E_e} cos^2(\theta/2)$
- $Q^2 = xys$

Measurement of Structure Function $F_2(x, Q^2)$

- $\frac{d^2\sigma}{dxdQ^2} = \frac{2\pi\alpha^2}{Q^4 x}[F_2(x, Q^2) - \frac{y^2}{Y_+}F_L(x, Q^2)]$
- Reduced Cross-section: $\sigma_R = \frac{Q^4 x}{2\pi\alpha^2}\frac{d^2\sigma}{dxdQ^2} = [F_2(x, Q^2) - \frac{y^2}{Y_+}F_L(x, Q^2)]$
- $\sigma_R = [F_2(x, Q^2) - \frac{y^2}{Y_+}F_L(x, Q^2)]$ where $Y_+ = 1 + (1 - y)^2$
- Structure Function: $F_2(x, Q^2) = \sigma_R(x, Q^2, y = 0)$

Measurement of Longitudinal Structure Function($F_L(x, Q^2)$)



- $$F_L(x, Q^2) = \frac{\sigma_{R,1}(x, Q^2, y_1) - \sigma_{R,2}(x, Q^2, y_2)}{y_2^2/Y_{2+} - y_1^2/Y_{1+}}$$

Electron Identification

- Tracking Detector(Momentum)
- Electromagnetic Calorimeter (Energy)
- Sources of Background : Non-ep background, Photoproduction

Measurement of Cross-section

- $$\frac{d^2\sigma}{dxdQ^2} = \frac{1}{\Delta x \Delta Q^2} \frac{N_{raw}}{(A \times \epsilon) \times L_{int}}$$
- N_{raw} = No. of measured particles,
- $\Delta(x), \Delta(Q^2)$ = width of x and Q^2
- (A*ϵ) =($acceptance * efficiency$), L_{int} =Integrated luminosity

Tool used for Data Analysis

- PYTHIA8 event generator (`https://pythia.org/`)
  - Two data sets are used ($\sqrt{s} = 318 GeV$ & $\sqrt{s} = 225 GeV$)
- ROOT data analysis framework (`http://root.cern.ch/`)