Measurement of $cos(\phi)$ and $cos(2\phi)$ asymmetries with CLAS12 experiment

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Introduction

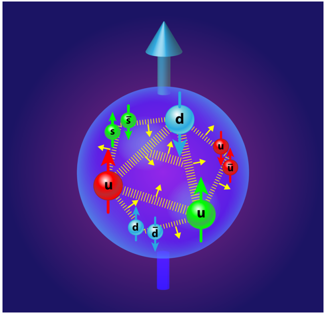


Figure: The inside of a proton

- Proton made of 3 valence quarks
- Each quark has a spin and a momentum
- Study of spin-orbit correlation

  $\rightarrow$ Intrinsic motion of quarks inside the proton

Introduction

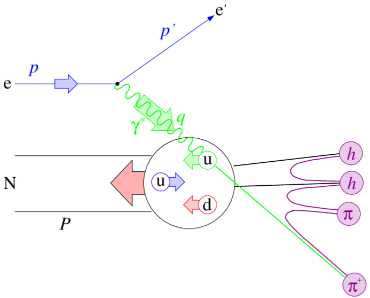
- Transverse Momentum Dependance (TMD) distribution functions describe the azimuthal distribution of partons inside nucleons.

- Boer-Mulders function : generates $cos(2\phi)$ asymmetry in unpolarized leptoproduction, coupled to Collins fragmentation function
  $\rightarrow$ describe the correlation between the transverse spin and momentum of a quark ejected from an unpolarized target in Semi-Inclusive Deep Inelastic Scattering (SIDIS).

- Goal of this thesis : Measurement of the Boer-Mulders function with CLAS12 experiment

- Extract the $cos(\phi)$ $cos(2\phi)$ asymmetries in unpolarized leptoproduction

Semi Inclusive Deep Inelastic Scattering



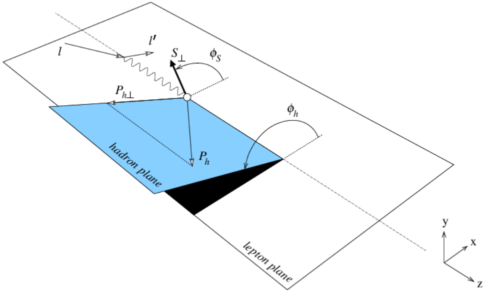
Electron scattered from a proton

At high enough Q² : scatter from a quark

SIDIS : a hadron is detected with the scattered electron

$\rightarrow$ Here the hadron is a π^+

Semi Inclusive Deep Inelastic Scattering



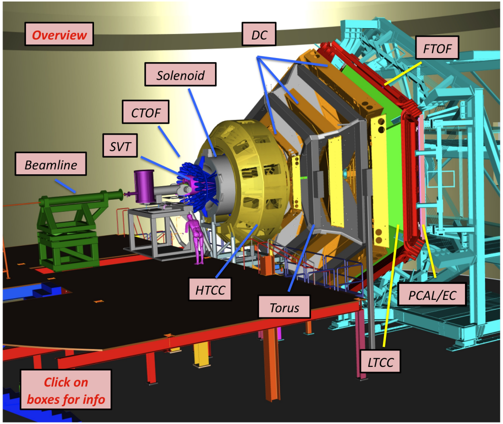
ϕ : azimuthal angle between lepton scattering plane and hadron production plane

This angle is correlated with transverse momentum of quarks $\rightarrow$ TMDs

$$l(l) + p(P) \rightarrow l'(l') + h(Ph) + X(PX)$$

Jefferson Lab and CLAS12

Jefferson Laboratory in Newport News (VA)
Continuous Electron Beam Accelerator Facility (CEBAF)

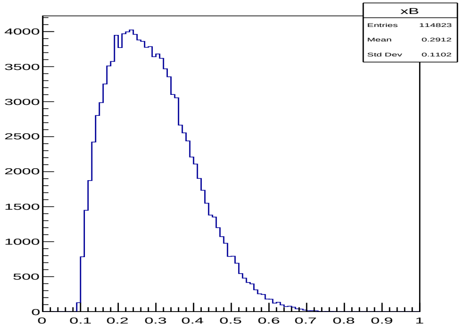


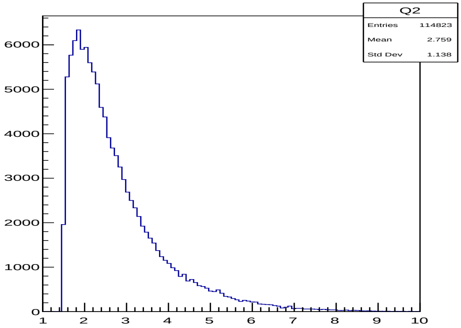
CLAS12 detector (CEBAF Large Acceptance Spectrometer 12 GeV)

$\rightarrow$ Electron beam 10.6 GeV

- Cherenkov counters
- EM Calorimeter
- Time of Flight counters
- Tracking

Kinematic Variables

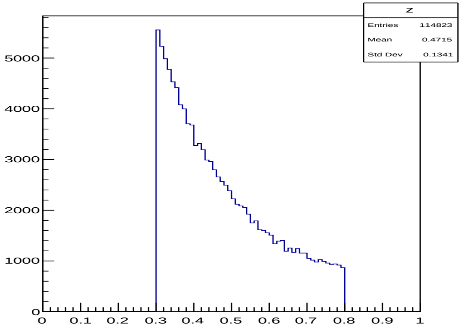


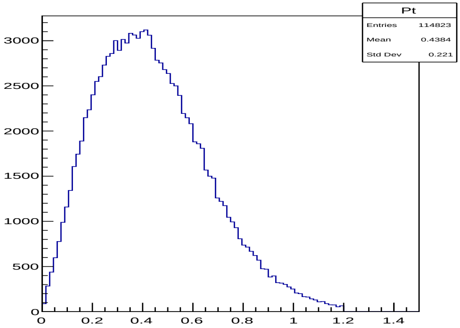


x_B : fraction of the proton momentum carried by the struck quark
Q^2 : 4 momentum transfer

$$x_B = \frac{Q^2}{2.p.q} \qquad Q^2 = (l^{'} - l)^2 \qquad Q^2 > 1.5\,Gev^2$$

Hadronique variables





z : fractional energy transfered to hadron

P_T : transverse momentum of hadron

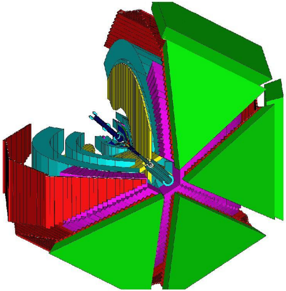
$$z = \frac{E_\pi}{\nu} \qquad 0.3 < z < 0.8 \qquad P_t = \frac{|\vec{p_h} \times \vec{q}|}{|\vec{q}|} \qquad P_T < 1.2 GeV$$

Objectives of the analysis

- Extract $cos(\phi)$ and $\cos(2\phi)$ with the asymmetry defined in experiments

$$< cos(\phi) >= \frac{\sum cos(\phi)}{N}$$

- Apply corrections (acceptance, radiative...)



$\rightarrow$ 6 sectors

$\rightarrow$ Triangular shape

$\rightarrow$ Big acceptance and radiative effects

Simulations

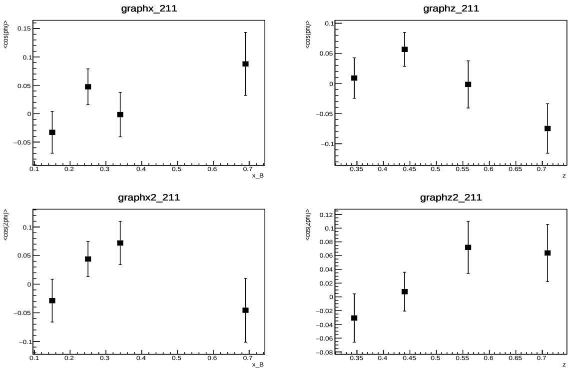
- SIDIS simulations in CLAS12

  $\rightarrow$ Simulate the particles through CLAS12 with Pythia event generator and GEMC CLAS simulation

- Fit the pion spectrum with the form $A + Bcos(\phi) + Ccos(2\phi)$

- Extract the $cos(\phi)$ and $cos(2\phi)$ asymmetries and conclude on the Boer-Mulders function

Preliminary results



⚠ Not really physical results

Need of acceptance correction

$cos(\phi)$ and $cos(2\phi)$ asymmetries in function of the different kinematic variables

Results

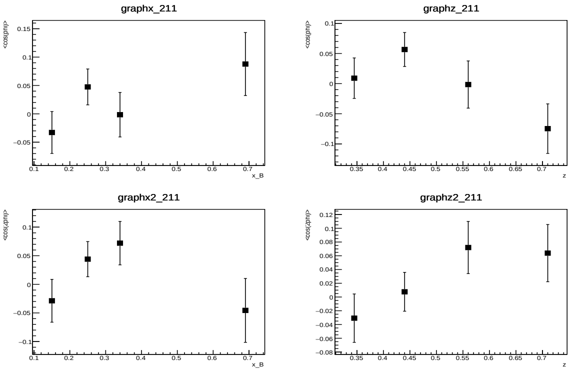


Figure: Data analysis

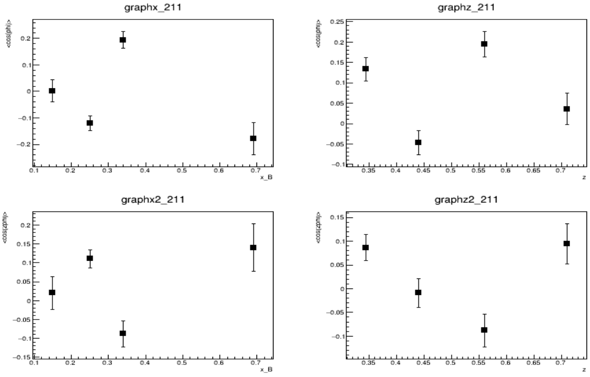


Figure: Simulation

Simulation without ϕ modulations show large asymmetries du to the detector geometry

Thank You