$\pi+$ cross section measurement with Eg2 experimental data

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Outline

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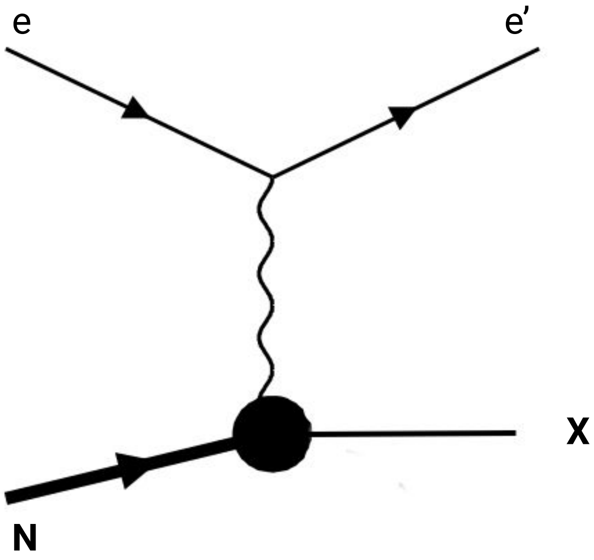
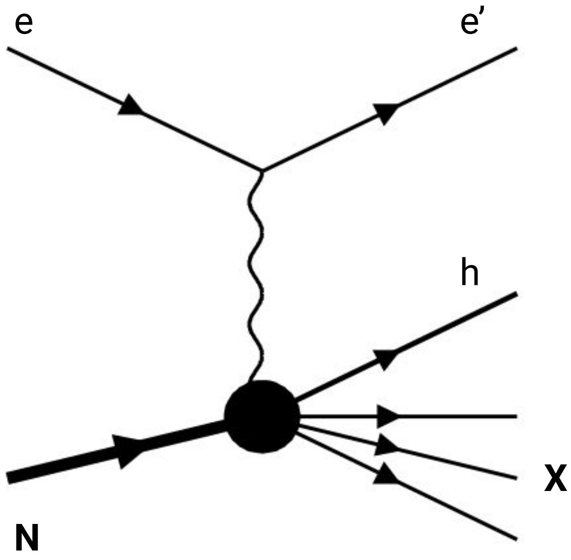
2. Eg2 experiment
3. Motivation
4. Calculations
5. Results

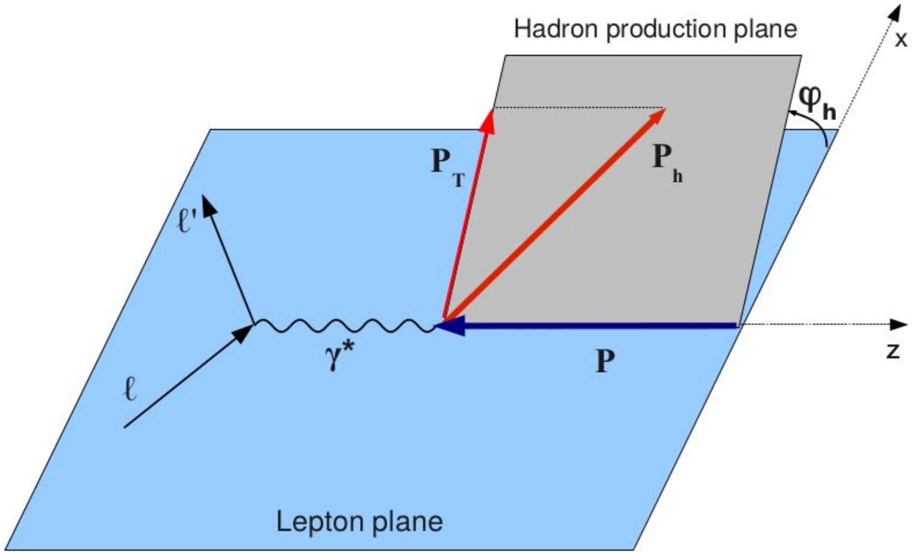
SIDIS





- **N** -> Nucleon or nucleus
- h -> Detected hadron
- X -> The unknown

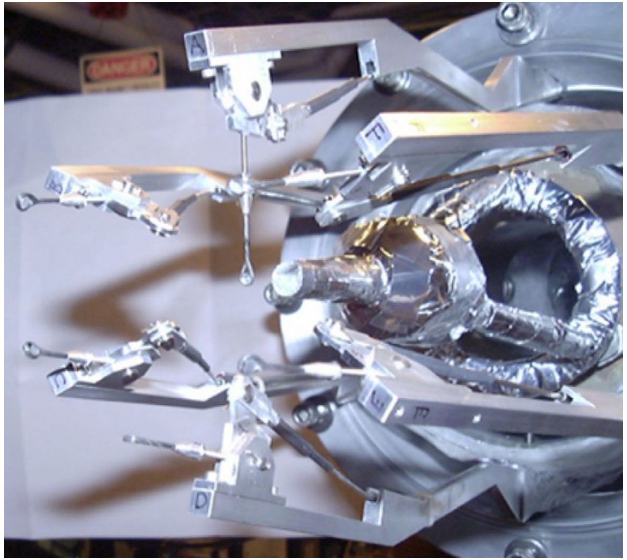
SIDIS



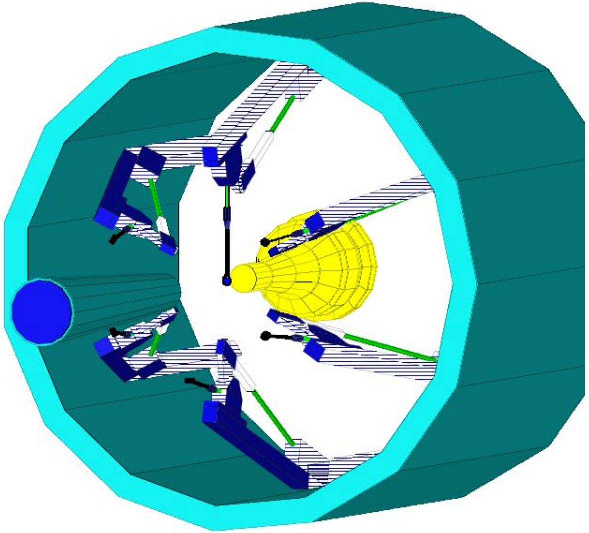
- Usually defined with five kinematical variables
  - **Q²** : Invariant mass virtual photon
  - **Xb** : Bjorken scaling variable
  - **Zh** : Fraction of momentum that the produced hadron receives from virtual photon
  - **Pt**:Transverse momentum of produced hadron
  - ϕ_h Angle between the hadronic production plane and the leptonic plane
- More details on nucleon structure dynamics

Eg2 experiment

- Double target system
- The liquid cryo target and the solid target are simultaneously exposed to the beam
- Same luminosity for both targets (approx.)



Eg2 double target

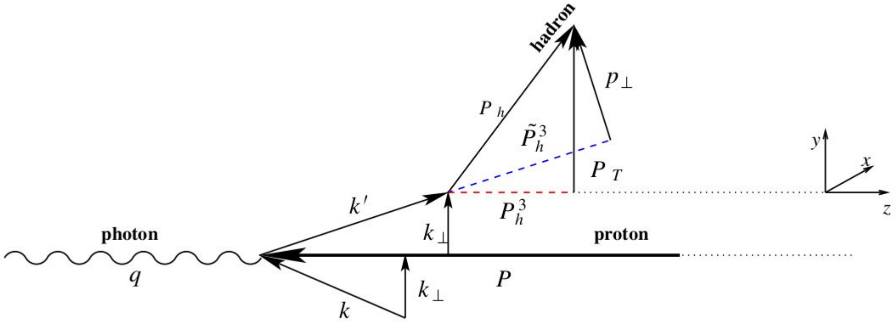


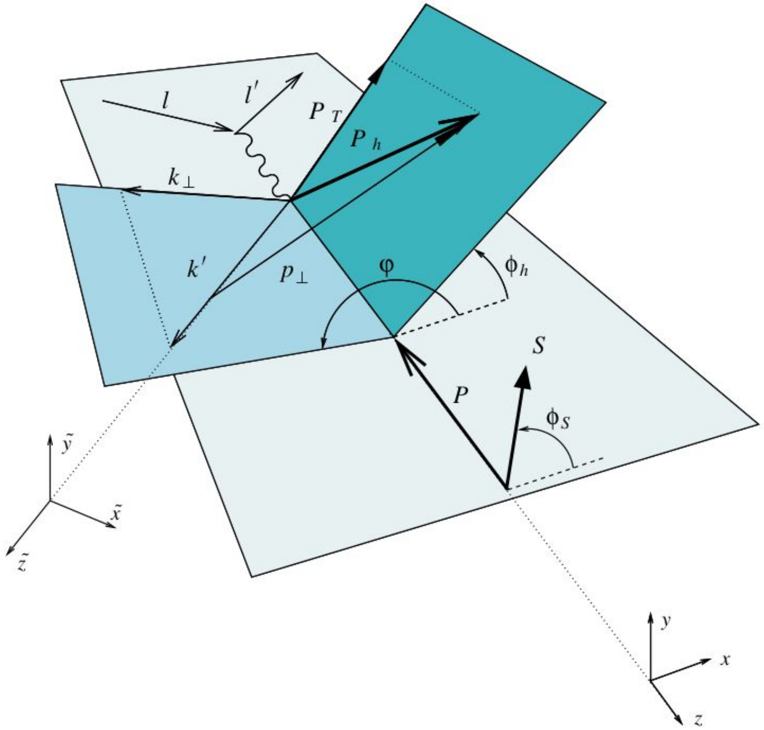
Eg2 double target simulation

Motivation

k : Intrinsic quark momentum -> Partonic motion inside the nucleon

Why is it important? Introduces important effects





k: Intrinsic quark momentum, pre scattering
k': Intrinsic quark momentum, post scattering, pre hadronization

Motivation

k : Intrinsic quark momentum -> Partonic motion inside the nucleon

Why is it important? Introduces Cahn effect

$$\frac{d\sigma}{dQ^2 dX_b dZ_h dP_t^2 d\phi_h} \propto A + B \cdot cos(\phi_h) + C \cdot cos(2\phi_h)$$

Azimuthal modulations are due to taking into account this intrinsic partonic motion [1]:

- **k** will be better represented by its transversal component with respect to the virtual photon direction: **kt**
- **kt** also can be found in models of structure functions
- We can extract a representative quantity for **kt** from the eq. above

Measuring <kt^2> allows to understand more the azimuthal

behavior of the measured hadron

Cross section measurement

First step towards a <kt²> measurement: Cross section measurement

- 5 dimensional analysis
  - Avoid model dependence bias in the analysis
- Binning
  - Q^2 : 10 bins in [1,4]
  - Xb : 8 bins in adaptative range
  - Zh : 8 bins in [0.2,0.8]
  - Pt^2: 8 bins in [0,1]
  - ϕ_h : 12 bins in [-180,180]
  - Total : 61440 five dimensional bins

Cross section measurement

Differential cross section calculation:

$$\left(\frac{d\sigma}{dQ^2 dX_b dZ_h dP_t^2 d\phi_h}\right)_{exp} = \frac{N_{corr}(Q^2, X_b, Z_h, P_t^2, \phi_h)}{\Delta Q^2 \Delta X_b \Delta Z_h \Delta P_t^2 \Delta \phi_h} \cdot \frac{1}{\mathcal{L}_{int}}$$

Where:

$$N_{corr}(Q^2, X_b, Z_h, P_t^2, \phi_h) = \frac{N_{data}(Q^2, X_b, Z_h, P_t^2, \phi_h)}{Acc_{5dim} \cdot RC_{5dim}}$$

$$\mathcal{L}_{int} = (\#\ \text{Electrons in FC}) \times \left(\frac{\#\ \text{Nucleonic targets}}{\text{Area}}\right)$$

Acceptance

The acceptance is defined as:

$$Acc_{5dim} = \left(\frac{\#\ \text{Reconstructed events}}{\#\ \text{Generated events}} \right)_{(Q^2, X_b, Z_h, P_t^2, \phi_h)}$$

- To obtain generated events **PYTHIA 6.319** was used
- To obtain the reconstructed events **GSIM** was used
  - Ideal detailed simulation of the detector geometry
  - Afterwards post processor is used to reproduce the inefficiencies of the detector.
- Simulations were made by Hayk Hakobyan

Radiative Corrections

The Radiative Correction factor is defined as:

$$RC_{5dim} = \left(\frac{\sigma_{obs}}{\sigma_{Born}} \right)_{(Q^2, X_b, Z_h, P_t^2, \phi_h)}$$

- To calculate this factor a C++ version, developed by Hayk Hakobyan, of the HAPRAD code was used
- HAPRAD is based on the QED calculations of Akushevich et al.[2]
- It's specially designed for the unpolarized SIDIS case

Results

As a start we calculate experimentally:

$$\frac{d\sigma}{dQ^2 dX_b dZ_h}$$

Why? Because theoretically is more simple than the five-fold differential cross section, and there's results to check if our methodology is right

How? Integrating experimentally in Pt^2 and ϕ_h

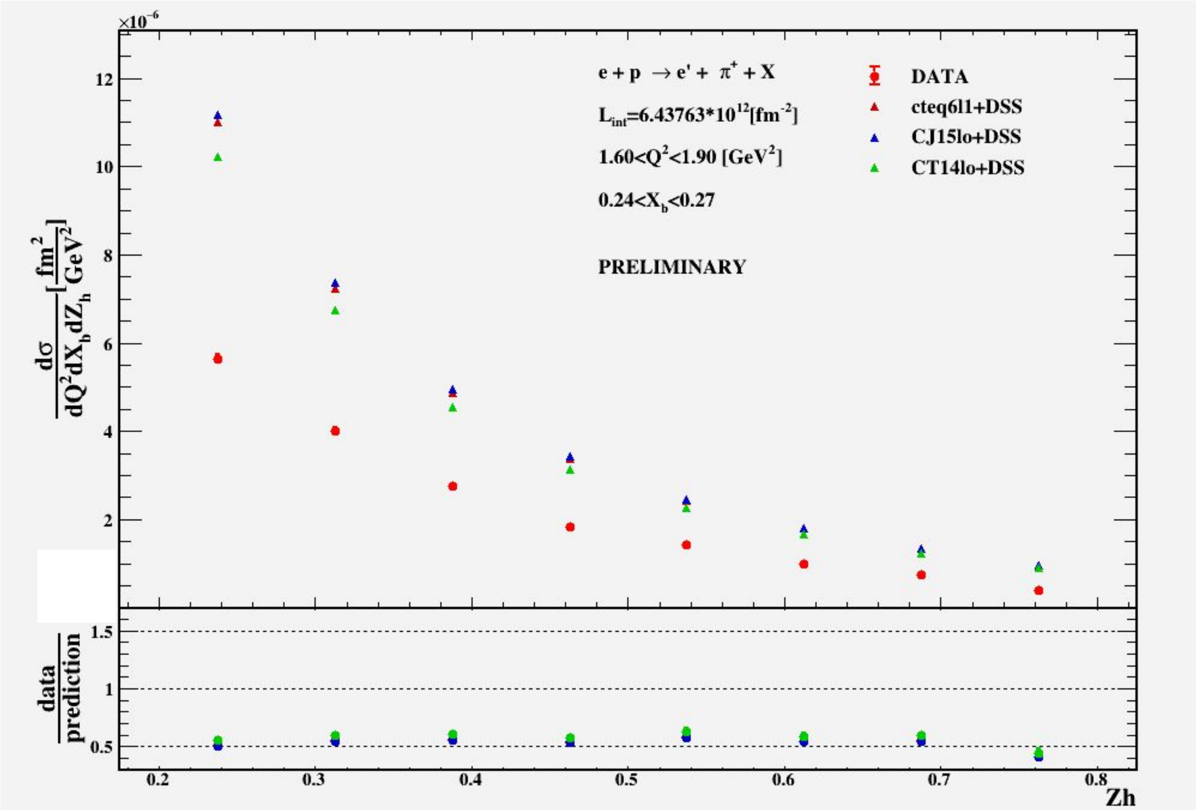
Results

We'll compare our results to the theoretical expression derived from [3,4]:

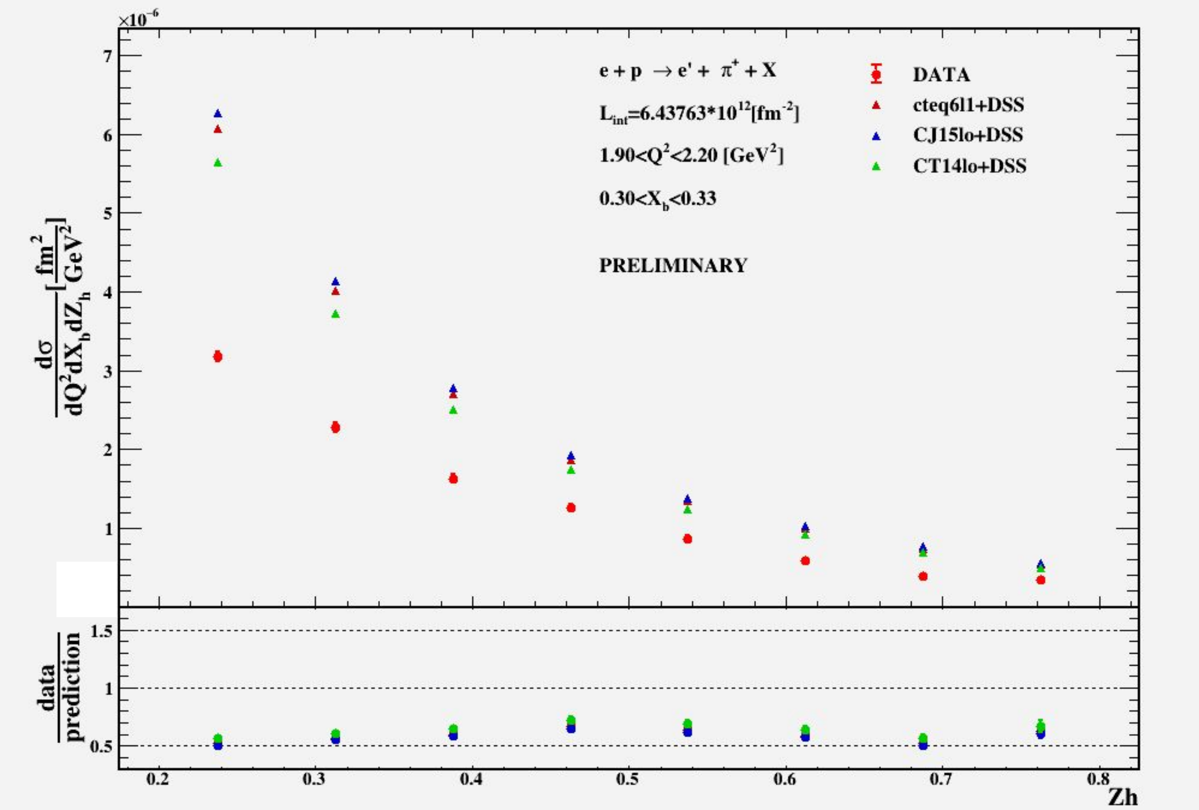
$$\frac{d\sigma}{dQ^2 dX_b dZ_h} = \frac{4\pi\alpha}{Q^4}\left(1 - y - \frac{M \cdot X_b \cdot y}{2E} + \frac{y^2}{2\kappa \cdot R}\right)\sum_q e_q^2 f_q(X_b) \cdot D_q^{\pi^+}(Z_h)$$

- Only statistical errors will be included
- Only central values in the theory

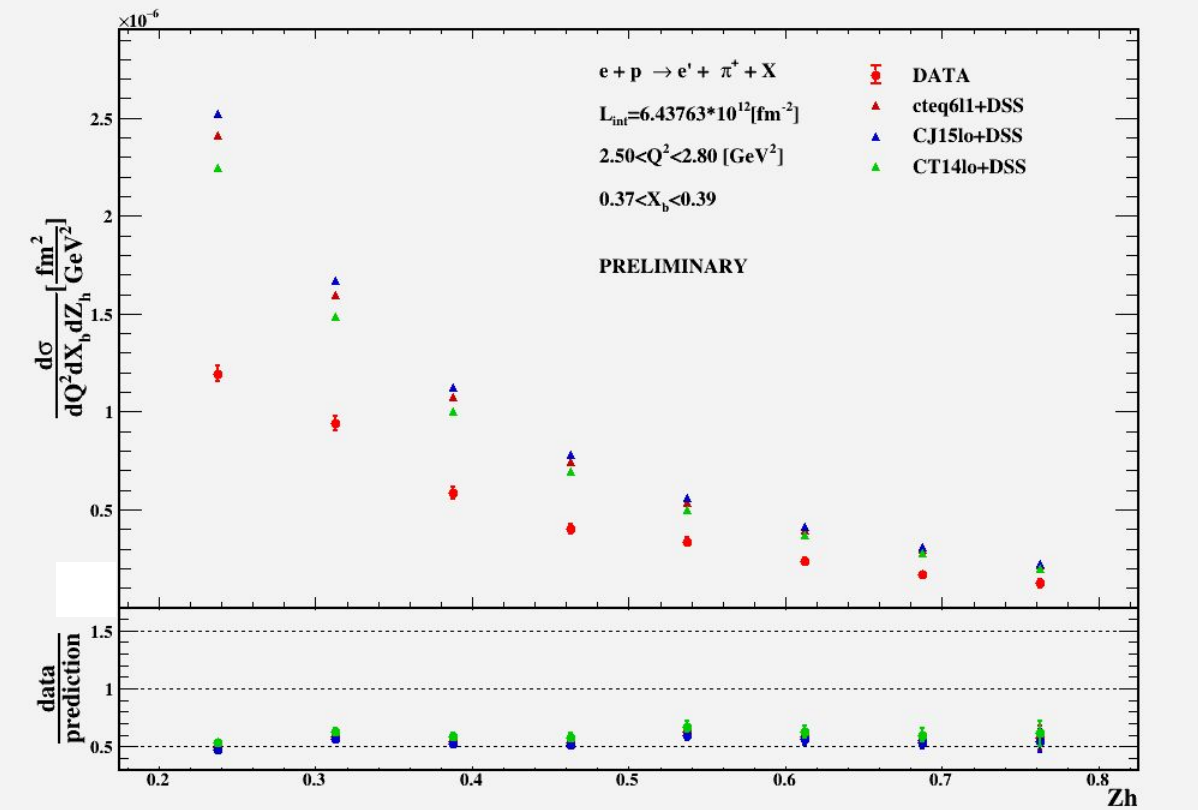
Results: Proton target



Results: Proton target



Results: Proton target



References

1. *Anselmino, M. et al., “Role of Cahn and Sivers effects in Deep Inelastic Scattering”, 2005.*
2. *Akushevich, I. et al., “Radiative Effects in the Process of Hadron Electroproduction”, 1999.*
3. *Levelt, J., Mulders, P.J., “Quark Correlation Functions in Deep Inelastic Semi-Inclusive Processes”,1993.*
4. *Osipenko, M. et al., “Measurement of Semi-Inclusive π^+ Electroproduction off the Proton”,2009.*