DiHadron analysis at CLAS

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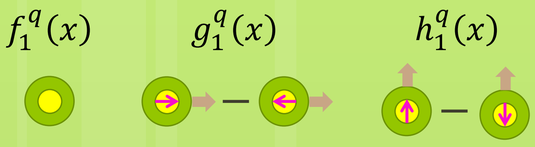
Physical motivations

In the collinear approximation, the nucleon is described through 3 Parton Distribution Functions:

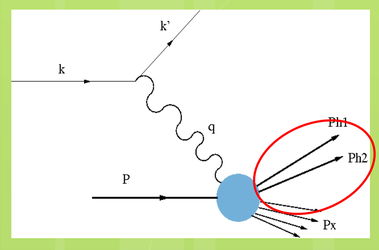
$f_1^q(x)$ $g_1^q(x)$ $h_1^q(x)$



- $f_1^q(x)$: ***known with high accuracy***
- $g_1^q(x)$: ***less well known (Hermes data for 5 different quark flavours*)***
- $h_1^q(x)$: ***unknown***

Since ***transversity does not appear in DIS***, its experimental investigation relies on processes where one or more hadrons are detected **in the final state**.

Two-Hadron SIDIS



Semi-Inclusive Deep Inelastic Scattering (SIDIS)

$$l(k)+N(P)\rightarrow l'(k')+X(P_X)+h_1(P_{h_1})+h_2(P_{h_2})$$

- As a SIDIS process, it allows to extract $h_1^q(x)$
- With respect to the single-hadron production, it provides an easier access to $h_1^q(x)$
  - $h_1^q(x)$ appears in the single-hadron cross section in a convolution integral

$$\frac{d^6\sigma}{d\ldots}\approx\ldots\Im\left[\frac{k_T\cdot\hat{P}_{h\perp}}{m_P}h_1^q H_1^{\perp q}\right]$$

  - ...while it appears in a direct product in the two-hadron cross section

$$\frac{d^7\sigma}{d\ldots}\approx\ldots h_1^q(x)H_1^{\sphericalangle q}$$

- Through the extraction of the Beam-Spin Asymmetry, one can access the structure function

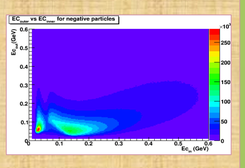
$$F_{LU}^{\sin\phi_R}=-x\frac{|\boldsymbol{R}|\sin\theta}{Q}\left[\frac{M}{M_h}x e^q(x)\,H_1^{\sphericalangle q}(z,\cos\theta,M_h)+\frac{1}{z}f_1^q(x)\,\tilde{G}^{\sphericalangle q}(z,\cos\theta,M_h)\right]$$

The extraction of the PDF is possible since the interference fragmentation function has been recently extracted from Belle measurement**

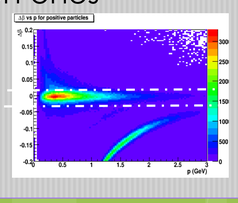
Particle Identification & event selection

$$e\,p\rightarrow e'\,\pi^+\,\pi^-\,X$$

- $p_e > 0.8\ GeV$
- $n_{phe} > 25$
- $ec_{InnEn} > 0.06\ GeV$
- $0.2 < \frac{E_{Tot}}{p} < 0.36\ GeV$

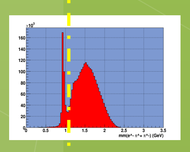


- Cuts complementary to the electron ones
- $\Delta\beta < 0.02$



- The events with at least one π^+ and one π^- are selected
- When more than one $\pi^\pm$, the various combinations are considered
- DIS cuts are applied: W > 2 GeV && Q^2 > 1 GeV^2
  - ✓ W > 2 GeV removes the resonance region
  - ✓ Q^2 > 1 GeV^2 to be in deep inelastic region
- Missing mass cut in order to remove exclusive events ($mm_X > 1.05\ GeV$)
  - ✓ The missing mass mm_X of the system $e^-\,\pi^+\,\pi^-$ is defined as the invariant mass of the following 4-Vector:

$$P_X(e^-,\pi^+,\pi^-)=(P_{tar}+P_{beam})-(P_{e^-}+P_{\pi^+}+P_{\pi^-})$$



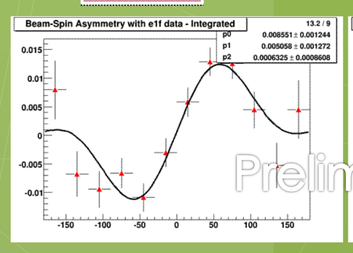
Beam-Spin Asymmetry

$$A_{LU}=\frac{1}{P_{beam}}\frac{N^+-N^-}{N^++N^-}$$

$$p^0\sin\varphi+p^1\sin 2\varphi+p^2$$

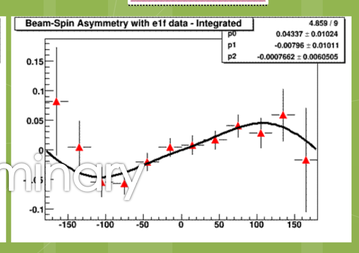
Sin(Φ) moment → 0.0086 ± 0.0012
Sin(2Φ) moment → 0.0050 ± 0.0013
Constant term compatible with zero

$x_{F\pi^\pm} > 0$



Sin(Φ) moment → 0.0086 ± 0.0012

$x_{F\pi^\pm} > 0.2$



Sin(Φ) moment → 0.043 ± 0.010

- P_{beam} is the beam polarization
- N^+: number of dihadron events corresponding to a + beam-helicity
- N^-: number of dihadron events corresponding to a - beam-helicity

CLAS@Jlab & e1f experiment

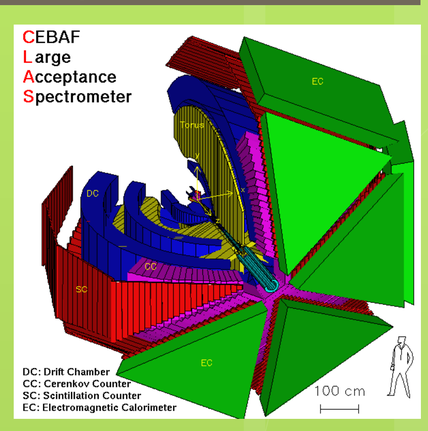
The ***Cebaf Large-Acceptance Spectrometer* (CLAS)** is installed in the Hall-B of the Thomas Jefferson National Accelerator Facility (Newport News, VA, USA). It is a natural enviroment to perform SIDIS measurements.

The CLAS detector is provided with:

- Toroidal magnetic field (6 supercondicting coils)
- Drift chambers (argon/CO2 Gas, 35000 cells)
- Time-of-flight scintillators
- Electromagnetic calorimeters
- Cherenkov counters (e/π separation)

Its features allow the following performances:

- **Nearly 4π acceptance**
- **Large kinematical coverage**
- **Detection of charged and neutral particles**



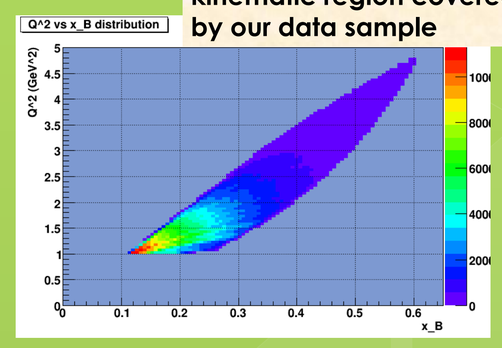
e1f experiment took place in Hall-B in the period April – June 2003.

- **Longitudinally polarized electron beam with average polarization of 75 %**
- **Integrated luminosity of about 21 fb^{-1}**
- **Target: unpolarized liquid hydrogen**
- **Beam energy: 5.5 GeV**

Analysis procedure & kinematical coverage

1. **Particle identification**
2. **Event selection**
   - **DIS cuts**
   - **Semi-inclusive cuts**
   - **Current-fragmentation region cuts**
3. **Extraction of the Beam-Spin Asymmetry**

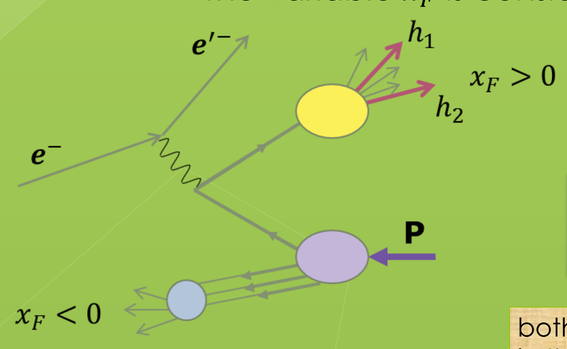
kinematic region covered by our data sample



Total number of $\pi^+\,\pi^-$ pairs in the e1f data set: 2.37×10^6

Current Fragmentation Region

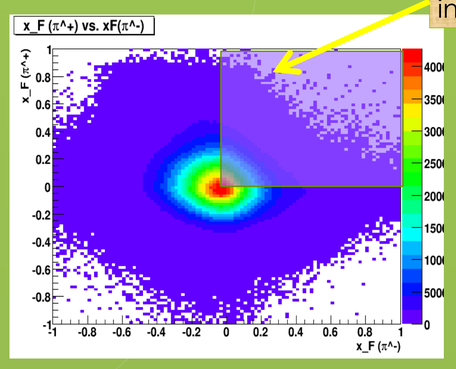
The variable x_F is considered to select the hadrons in the CFR:

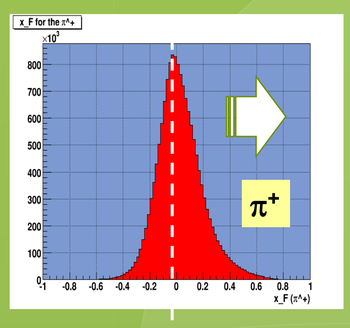


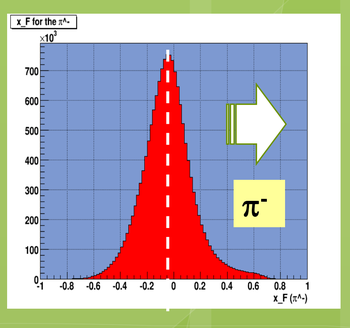
$$x_F(\pi^\pm)=\frac{2p_{\parallel}}{W}>0$$

where *W* is the γ^*-**p** centre-of-mass energy and $p_{||}$ is the longitudinal component of the pion momentum (evaluated in the γ^*-**p** centre-of-mass).

both pions in the CFR







Conclusions & Outlooks

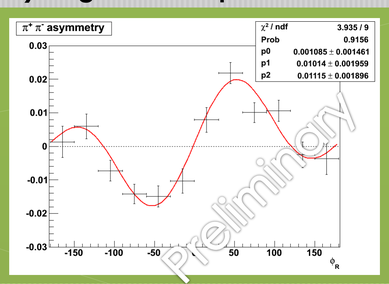
A non-zero A_{LU} is observed with 6 GeV CLAS data

- $\pi^+\,\pi^-$ channel analyzed
- Sin(ϕ) moment appears to be the dominant contribution
- A BSA dependence on z, x_B and mm($\pi^+\,\pi^-$) can be appreciated already at 6 GeV
- 1-D binning so far

Improvements ongoing

- Study of acceptance effects
- Analysis on MC
- Check the possibility of a multi-D binning
- Analysis of other two-pion channels ($\pi^+\pi^0$) with different CLAS data sets

Another DiHadron analysis ongoing @CLAS with a polarized nuclear target (NH3) – eg1-dvcs experiment



Analysis by S. Anefalos Pereira

References
**A. Airapetian et al. PRD 71, 012003 (2005).*
***BELLE Collaboration, A. Vossen et al., PRL (2011), 1104.2425.*