Production of ϕ-mesons with a Linearly-polarized Photon Beam at CLAS
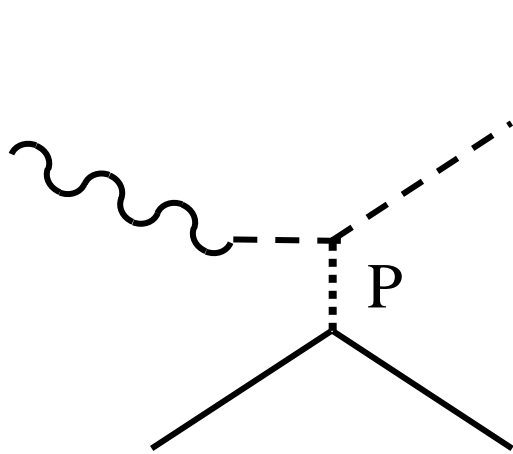
By Michael Wood
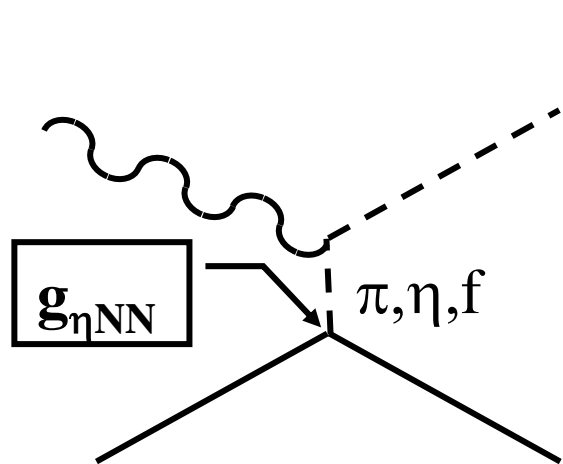
University of South Carolina

Motivation

The ϕ(1020) is unique in that it is the lowest mass $s\bar{s}$ state.
Its production can provide information on vector-meson production.
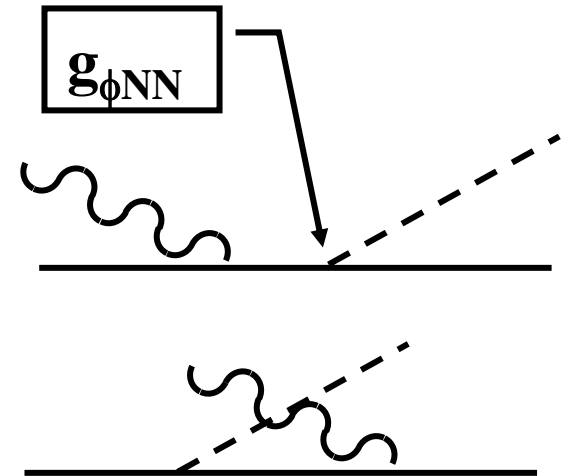

pomeron exchange

$J^\pi = 0^+$

→ **Observed at low |t|**
→ **Natural parity exchange**

meson exchange

$J^\pi = 1^-$

→ **Unnatural parity exchange**

s,u channel

→**OZI "evading" processes**
→**Possible hint to nucleon strangeness**
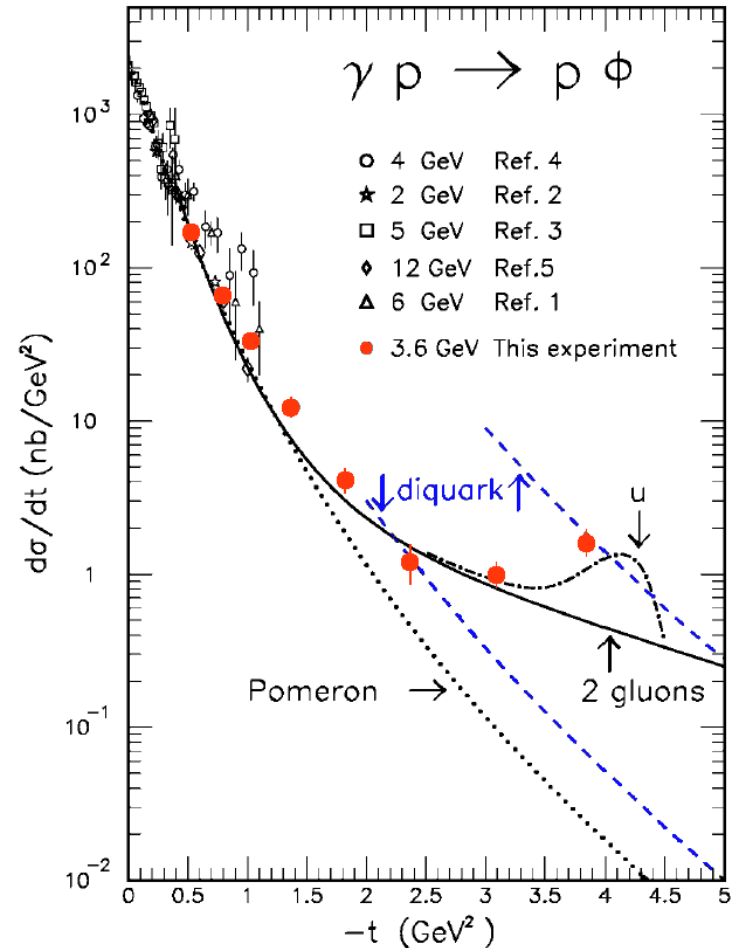
Previous Results

Unpolarized Cross section data :
[E. Anciant et al. Phys. Rev. Lett. 85, 4682 (2000)]

✓**CLAS data shows good agreement with previous measurements.**
✓**Structure at high momentum transfer |t|.**
✓**Possible nucleon exchange.**
✓**Need for more data – polarized observables.**
✓**Unpolarized data gives 3 density matrix elements(DME).**
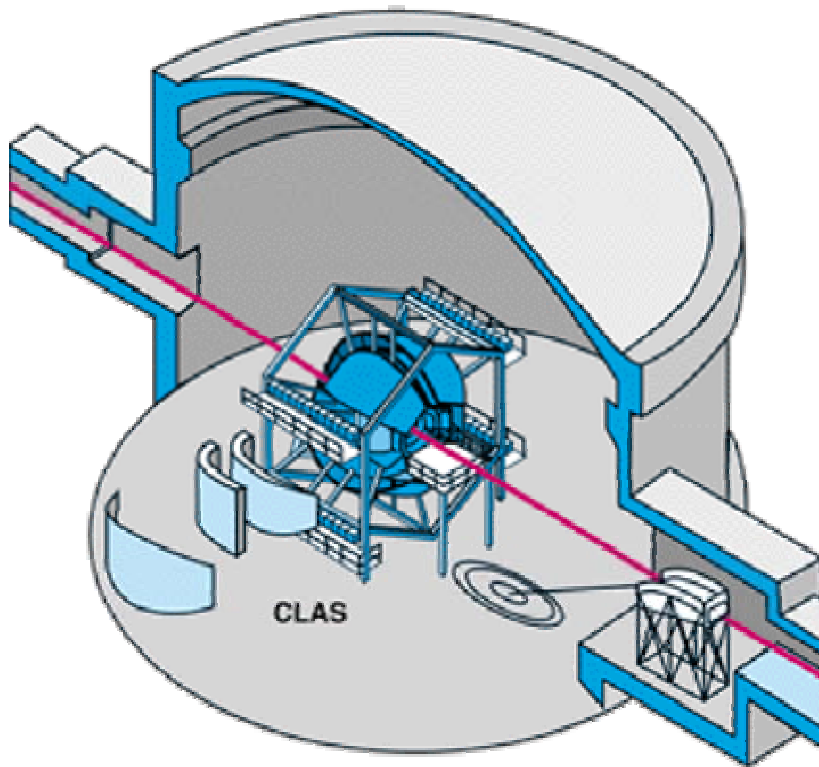✓**Polarized beam data gives 8 more DMEs**

References:
1) **R. L. Anderson et al., Phys.Rev. D1, 27 (1970)**
2) **H. J. Besch et al., Nucl. Phys. B70, 257 (1974)**
3) **H. J. Berends et al., Phys. Lett. 56B, 408 (1975)**
4) **D. P. Barber et al., Z. Phys. C12, 1 (1982)**
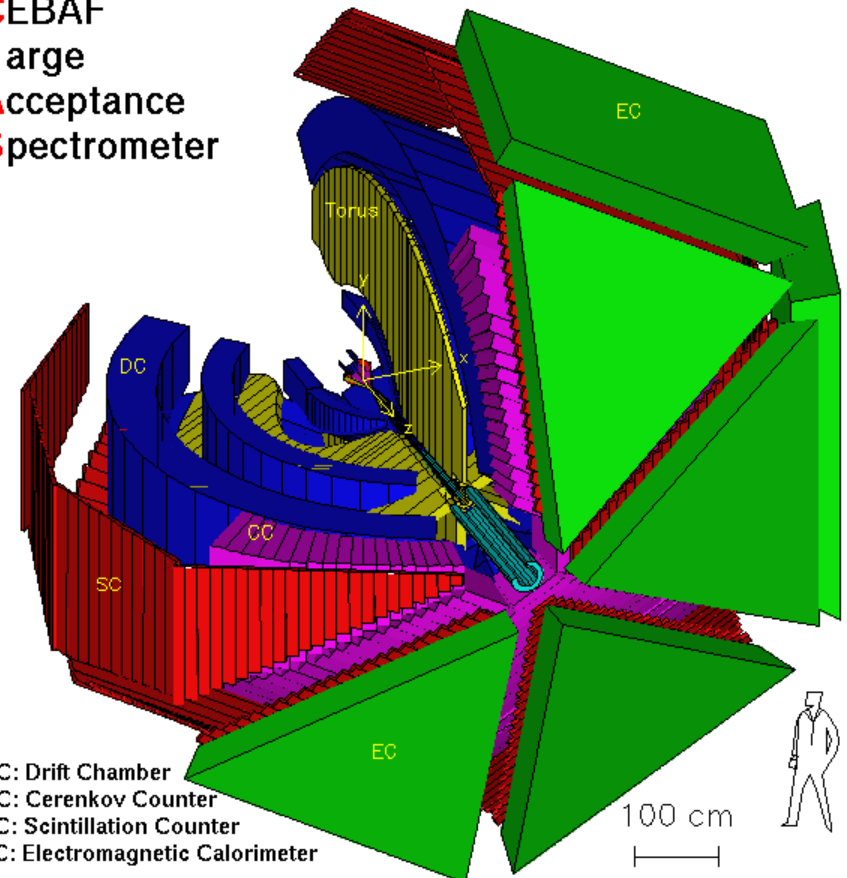5) **J. Ballum et al., Phys. Rev. D7, 3150 (1973)**

CLAS Detector

Hall B

CEBAF
Large
Acceptance
Spectrometer

CLAS

DC: Drift Chamber
CC: Cerenkov Counter
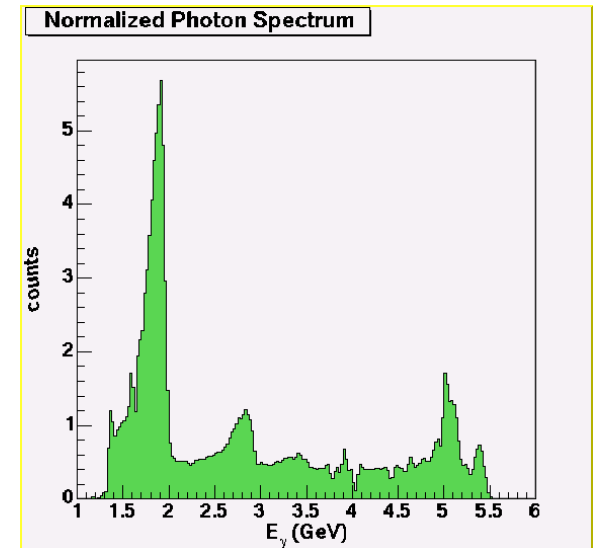SC: Scintillation Counter
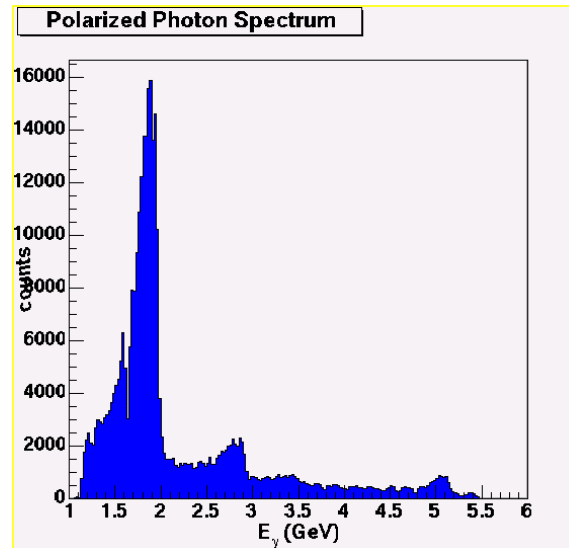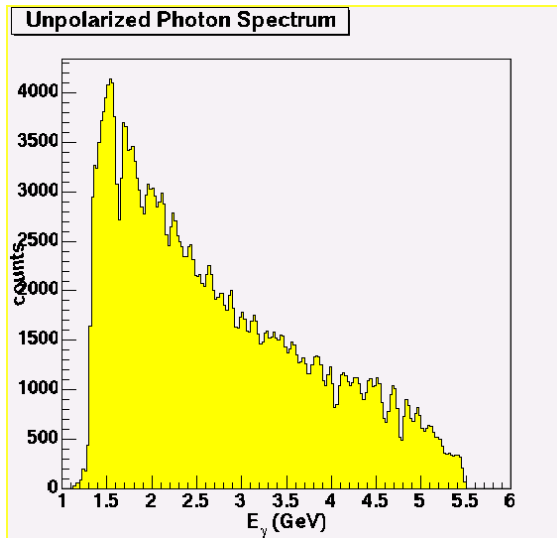EC: Electromagnetic Calorimeter

EC

EC

Torus

DC

CC

SC

100 cm

Linearly-polarized Photon Beam

Coherent Bremsstrahlung Facility
- **20- and 50-μm diamond radiators**
- **Goniometer oriented diamond for coherent radiation**
- **Average beam polarizations**
  - **Perpendicular – 78%**
  - **Parallel – 68%**

CLAS data

> **Photon energy : 1.8 GeV to 2.2 GeV.**
> **Liquid hydrogen target.**
> **Event selection: detect pK+, reconstruct K- .**
> **Λ(1520) cut: neglect events with pK-**
> **invariant mass between 1.5 GeV and 1.53 GeV.**
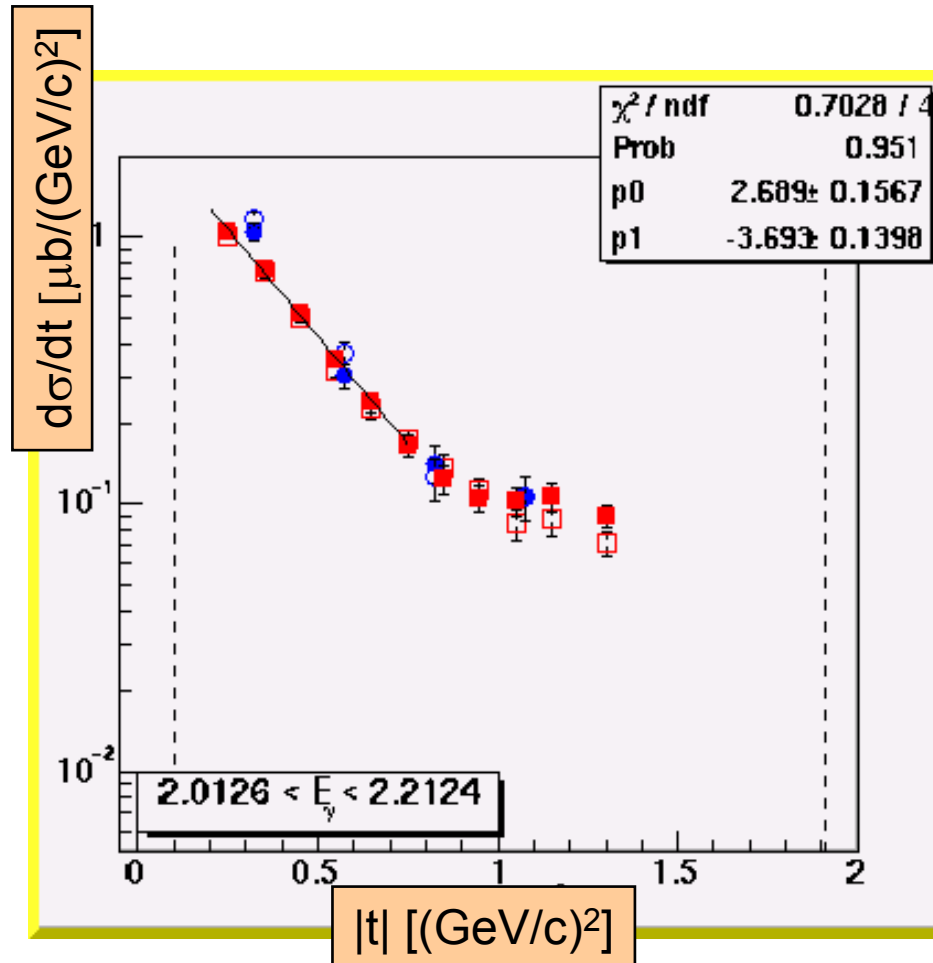> **Sideband subtraction to remove misidentified pions**
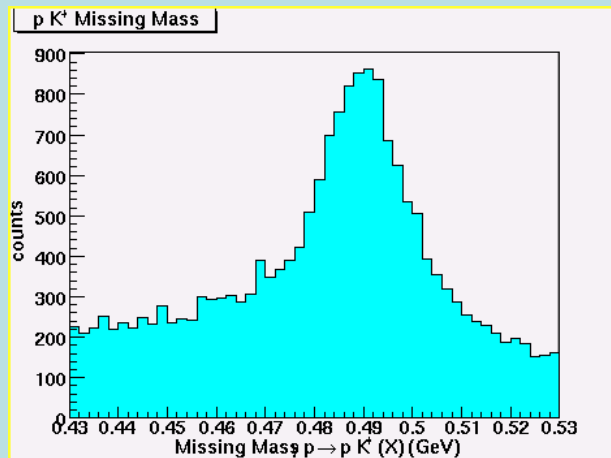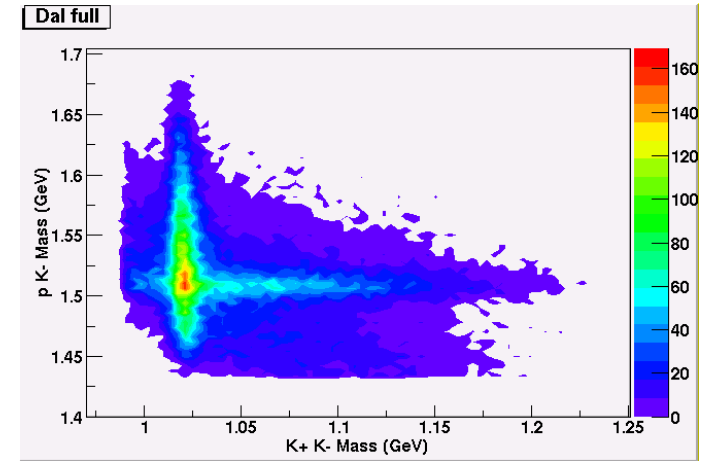
Due to low acceptance of K- in CLAS, most of the events are γp -> p K+ (X). Above is a plot of K- from missing mass.
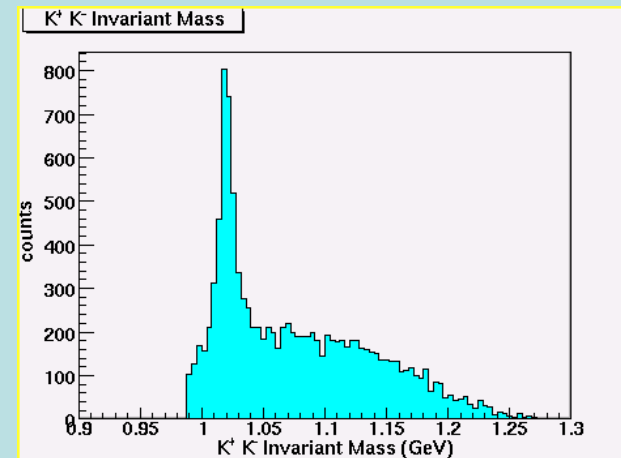
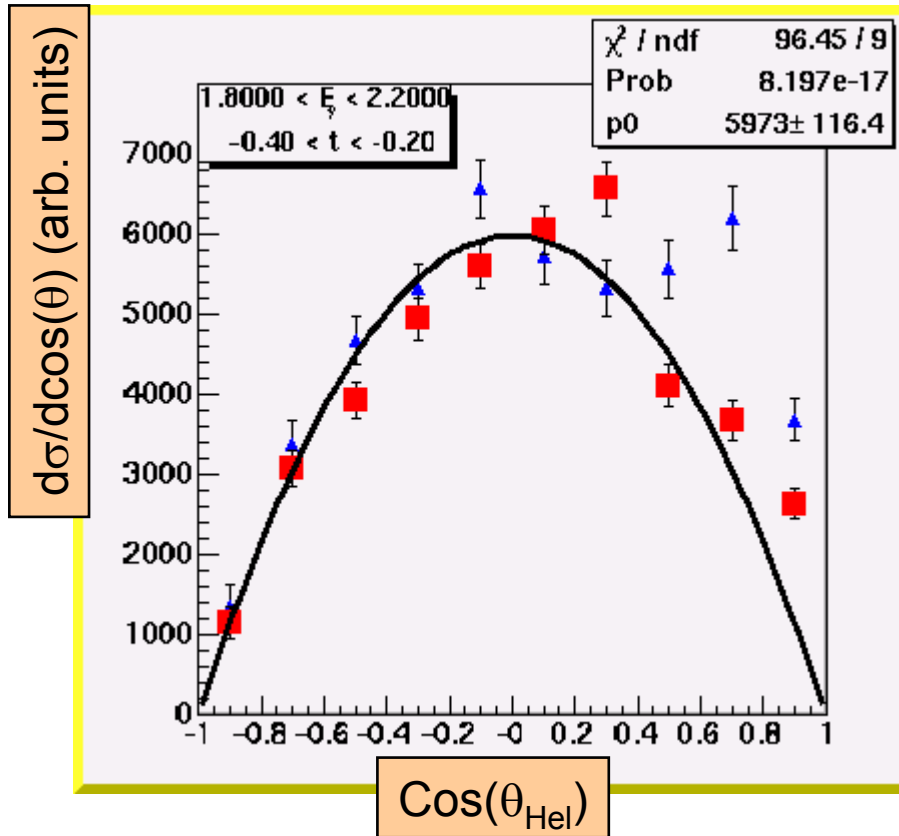**Above is a plot of the K+K- invariant mass spectrum.**
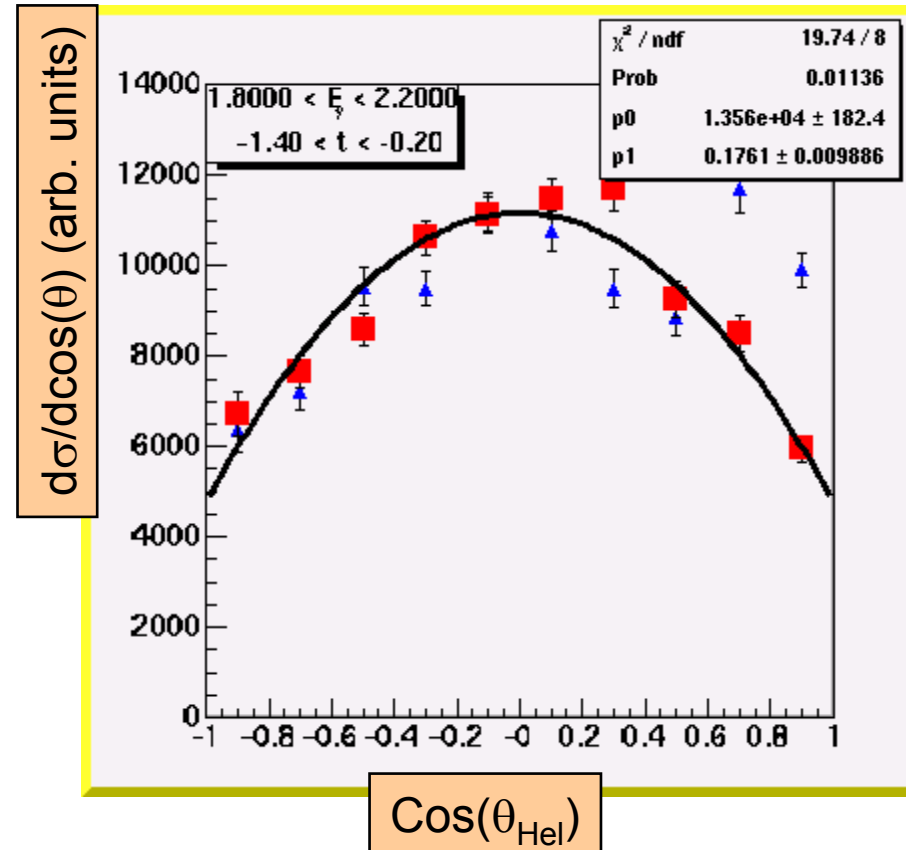
dσ/dt Distribution

- ➤ **Polarized data normalized to unpolarized data.**
- ➤ **Good agreement between polarized and unpolarized data sets.**
- ➤ **Diffractive shape at |t| < 0.5 (Gev/c)^2.**
- ➤ **Possible nondiffractive processes contributing at |t| > 1 (Gev/c)^2.**
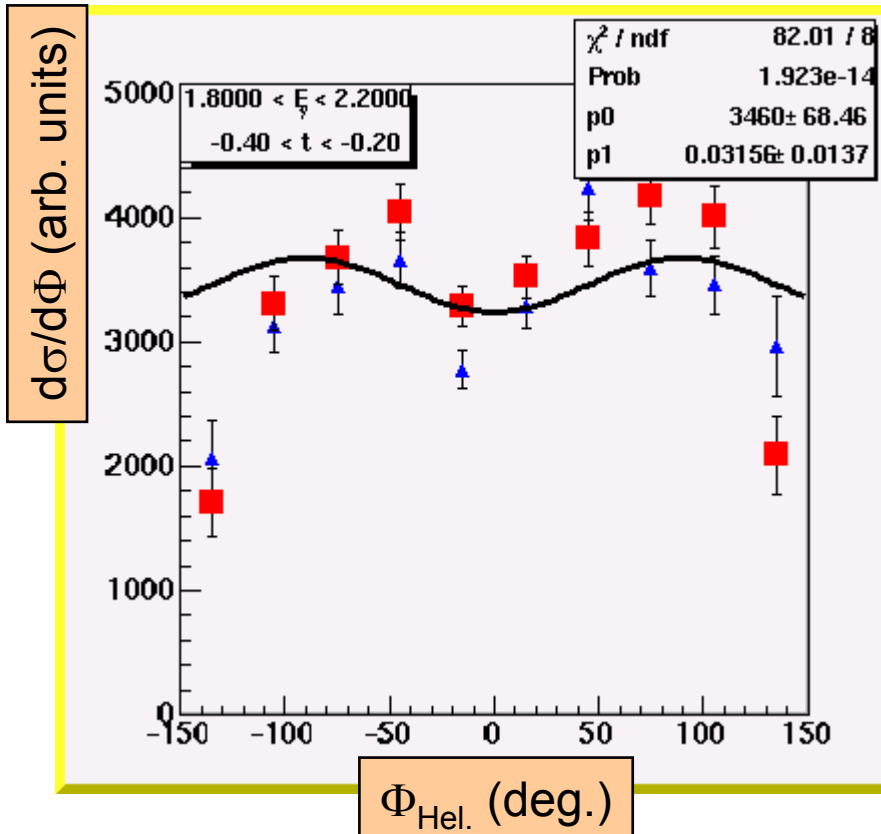
Helicity Frame Angular Distributions

0.2 < |t| < 0.4 (GeV/c)²

0.2 < |t| < 1.4 (GeV/c)²

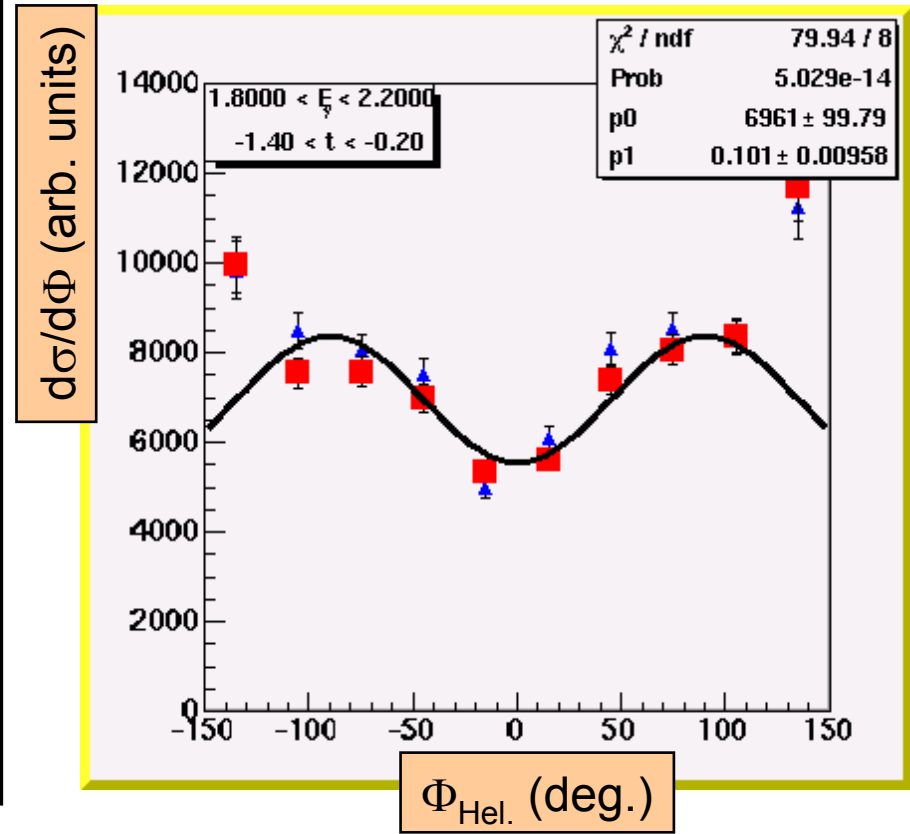
> Data : ■ - unpol., ▲ - perp. pol.
> At low |t|, data fit to sin²(θ) – diffractive shape.
> At high |t|, data deviates from diffractive process.
> Both data sets show the same behavior.

# Helicity Frame Azimuthal Distributions

0.2 < |t| < 0.4 (GeV/c)²

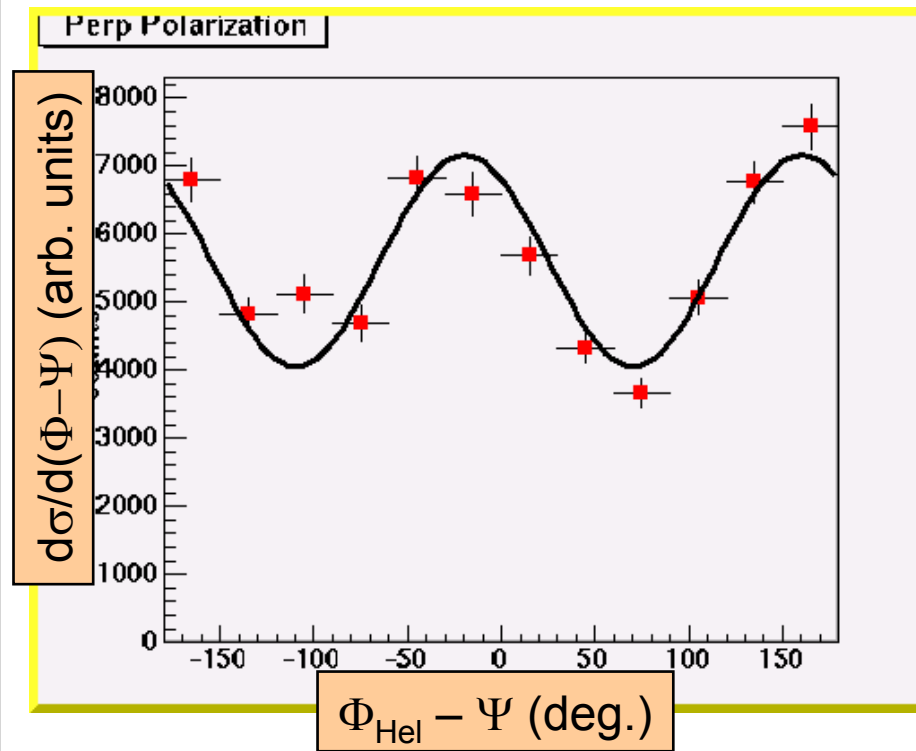**0.2 < |t| < 1.4 (GeV/c)²**

> Data : 🟥 - unpol., 🔺- perp. Pol. , fit to 1-cos(2Φ).
> Flatness of low |t| data indicative of diffractive process.
> Unpolarized and polarized distributions show similar behavior.
> Similar result in recent SAPHIR data [Eur. Phys. J. A17, 269 (2003)].
> Currently investigating our acceptance calculations.

$(\Phi_{Hel} - \Psi)$ Distributions

0.2 < |t| < 0.4 (GeV/c)²
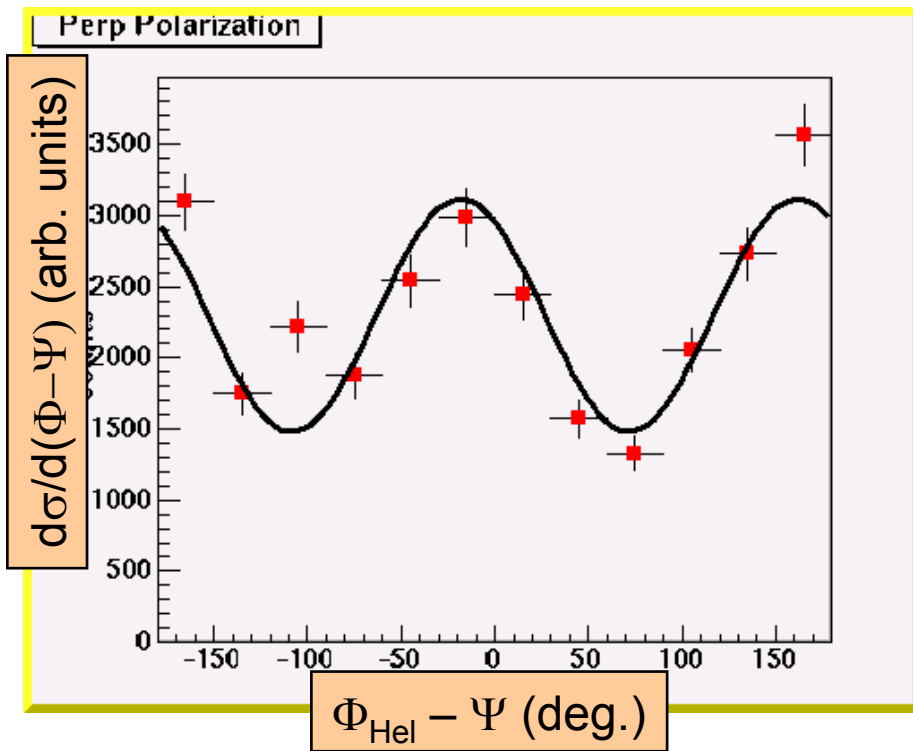
0.2 < |t| <1.4 (GeV/c)²

➤ **Angle Ψ is angle between polarized-beam electric vector and ϕ-meson production plane.**

➤ **Good fit of 1-cos[2($\Phi-\Psi$)] to data in both low and high |t| ranges.**

➤ **The shift from zero is under investigation.**

Summary

❖ CLAS has high quality data with unpolarized and polarized photon beams.

❖ For |t| <0.5 $(GeV/c)^2$, data consistent with the diffractive production.

❖ For |t|>0.5$(GeV/c)^2$, observed structures may indicate the need for new mechanisms.

❖ Both unpolarized and polarized data sets will be used to extract the spin density matrix elements.