



Proton polarization measurementsin π° photo-production--on behalf of the Jefferson Lab Hall CGEp-III and WACS collaboration

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Outline

Introduction

- Physics motivation
- \square π° photo-production kinematics
- Polarization measurement
- π° events identification:
 - $\Box \qquad 2 \ \gamma \ detected$
 - **Ω** 1γ detected
- Preliminary results

Transferred Polarization components

Summary







Physics motivation

Polarization transfer components at target: Px, Pz (P_t, P_l) Induced polarization: Py (P_n) Helicity independent variable.

1 Evidence of baryon resonances: In low photon energy range($E_{\gamma} < 2$ GeV), the π° production is dominated by the baryon resonances. This has been largely tested by the measurement of the cross section* and the induced polarization observable Py.

One would expect the polarization components to behave **smoothly** above the baryon resonance regime.

* D. Menze, et. al., Compilation of Pion Photoproduction Data (Physikalisches Institut der Universitat, bonn, 1977)



2. Hadron Helicity Conservation(HHC) Rule**: PQCD predicts the HHC. The HHC predicts that transferred polarization Px and induced polarization Py both vanish and Pz should become independent of beam energy at high energy.

** S.J Brodsky et. al., Phy. Rev. D 24, 2848(1981)





π° photo-production in GEp-III&2 γ , WACS experiments

A series of experiments in Hall C measured polarization of the proton during 2007-2008:

Electromagnetic form factor ratio (GEp-III&2y):

Wide-Angle Compton Scattering (WACS):

These experiments used the same technique and detectors to measure the polarization of proton.



π° photo-production:

The cross section is much larger than ep elastic and Compton Scattering at high Q².
similar kinematics
major contribution to the background

$$\vec{\gamma} + p \rightarrow \pi^{0} + \vec{p} \\ \mapsto \gamma + \gamma$$

Difference between two experiments Target used:

GEp-III&2γ 20 cm(5 cm) LH2 long target is equivalent to a 2.3% radiator. WACS 5 cm LH2 + 9% Cu radiator (a mixed

electron/ photon beam)





Kinematics of π° photo-production

> π° will decay into 2 γ (fraction 98.798%) right after its production > A DC threshold $\approx \frac{1}{2}$ Elastic

>The minimum open angle between the two gammas is determined by the energy of π° , in some of kinematics BigCal can detect both gammas.

EM Calorimeter: BigCal

High Momentum Spectrometer (HMS)



Polarized electron beam





Detectors



EM calorimeter detects particles in coincidence with a proton in the HMS Fine granularity (1744 blocks) for good angular resolution

Movable to match the angular acceptance of the HMS.

Focal Plane Polarimeter (FPP)



Two sets of drift chamber pairs (12 planes of detection) and CH_2 analyzer blocks.

The polarization of protons scattered in the analyzer blocks is revealed as an azimuthal angular distribution because of the strong interaction LS coupling.





Kinematics of π° photo-production

GEp-III& 2γ and WACS:

Experiment	E _e , (GeV)	P _p (GeV/ c)	θ _p (deg)	R _{BigCal} (cm)	E _y range (GeV)	θ _{C.M,} π° (deg)
GEp-2γ	1.867	2.068	14.49	493.2	1.6 - 1.86	135149.
	2.839	2.068	30.98	1200.0	2.35 - 2.73	89104.
	3.549	2.068	35.39	1116.4	2.615 - 3.38	7291.
GEp-III	4.053	3.589	17.94	605.0	3.400 - 3.980	115129.
	5.714	4.464	19.10	608.2	5.000 - 5.600	100119.
	5.714	5.407	11.6	430.4	5.000- 5.600	129143.
WACS	4.109	1.850	40.0	881.0	3.200-3.980	67.0-75.0

The polarization components of π° production were measured in Hall A experiment in range of $0.8 \text{GeV} < E_{\nu} < 4.0 \text{GeV}$. (K. Wijesooriya et al, Phys.Rev.C66: 034614(2002))

Note: polarization of π° photo- and electro-production was expected (and measured) to be the same in the Hall A experiment.

There were no previous measurement of π° photo-production in the region of GEp-III and WACS kinematics before.





π° event identification







π° event identification: 2γ found in BigCal

GEp-III: Q²=8.5 GeV² : BigCal at closest position and HMS in smallest angle.





Simulation result: After applying cut to data: temp2 π^0 events simulation 112.9 Entries count(a.u.) 005 Mean RMS 14.65 2000 open distance (cm) open distance (cm)





π° event identification: ψ found in BigCal



The $E_{measured}/E_{predicted}$ energy resolution has similar energy resolution to ep elastic data. Fit the $E_{measured}/E_{predicted}$ distribution as a gauss function for π °, and a Landau function for background. The total background contamination is about 7.7% for this kinematics with $E_{threshold} < E_{v} < E_{elastic}$ cut.





Polarization at FPP

GEp-III: $Q^2 = 8.5$ GeV² : BigCal at closest position and HMS at smallest angle.



BigCal energy and FPP analyzing power are calibrated by ep elastic events ; applied all the detector acceptance cut, correlation cut and anti-elastic cut. Note: background correction applied assuming the ratio of background contamination has uniform distribution. Using spin transfer matrix to calculate the polarization at the target













Preliminary results







Summary

> Identifying π° with two different methods give consistent polarization results

> Preliminary results for the polarization components in π° photo-production are consistent with results of dedicated experiment at the energies of GEp-2 γ kinematics.

> First measurement of π° photo-production polarization components in range of 5.0 GeV< E_v < 5.7 GeV.











... more events left than right

