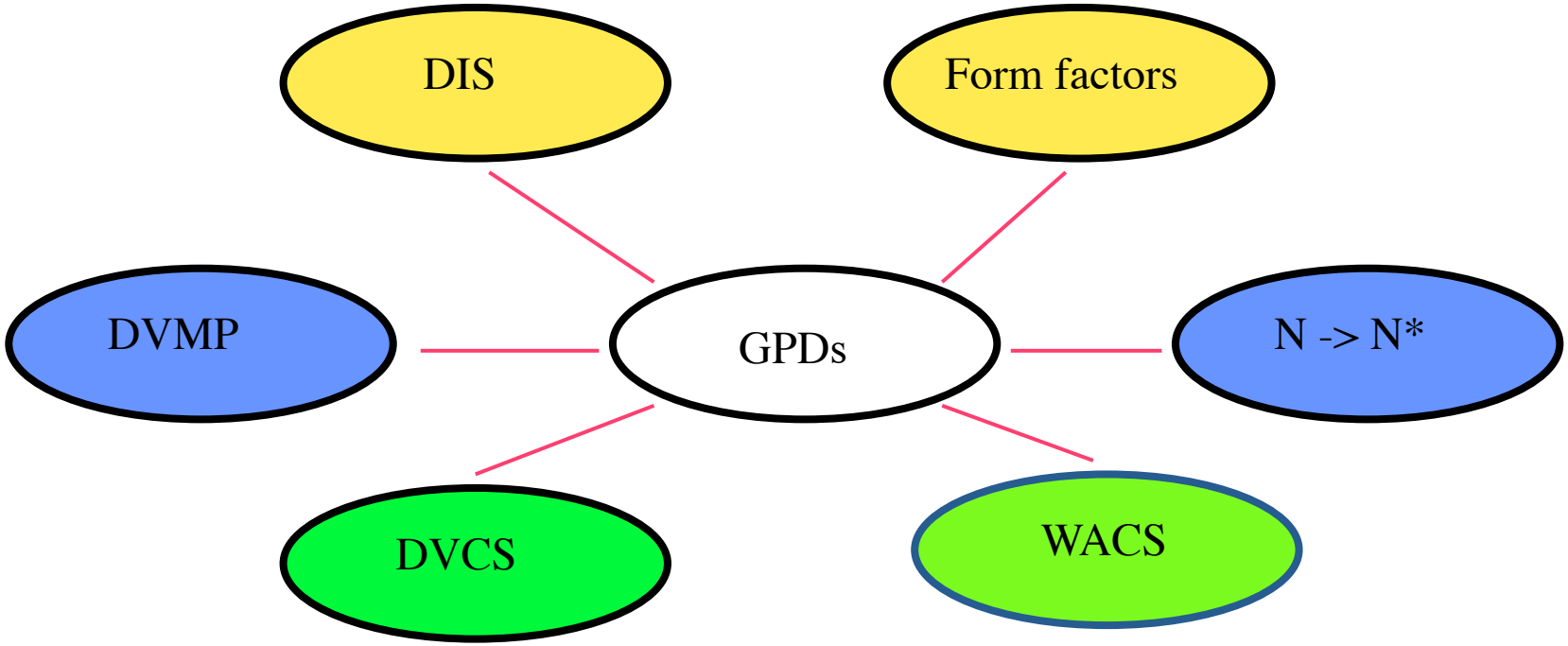
Compact Photon Source

It would be nice to understand better the mechanism of the pion photo-production from nucleon

B. Wojtsekhowski for the collaboration

Unification of nucleon structure within GPDs



x ξ t

Potential experimental program with the Compact Photon Source

1. Polarized NH_3 target – TCS: H(γ, e^+e^- p)
2. Polarized NH_3 target – exclusive pion: H(γ, π p), H(γ, π^+ n)
   Pion photo-production mechanism in GeV energy range

3. Polarized NH_3 target – phi-proton spin-spin: H(γ, K^+K^- p)
4. K_L secondary beam for use in Hall D experiments
5. Polarized ND_3 target – D(γ, p n) in high energy regime
6. Mirror nuclei T/^{3}He: Test difference of (γ, pn) yields
7. SRC in photo-induced disintegration: pn, pd, nd, … final states

The test of a handbag mechanism in exclusive photon-proton reaction

A_{LL} or K_{LL} – does not matter, we need just better data to constrain the GPD models

However, we can test of the handbag dominance more using the result: $A_{LL} = K_{LL}$

In reality, the WACS K_{LL} data has a modest accuracy ~ 0.09

Selection	K_{LL}	K_{LS}
$\text{WACS}_{\text{this experiment}}$	$0.645 \pm 0.059 \pm 0.048$	$-0.089 \pm 0.059 \pm 0.040$
$\text{WACS}_{\text{E99-114}}$	$0.678 \pm 0.083 \pm 0.04$	$0.114 \pm 0.078 \pm 0.04$
$\text{Pion}_{\text{this experiment}}$	-0.082 ± 0.007	-0.296 ± 0.007
$\text{Pion}_{\text{E99-114}}$	0.532 ± 0.006	0.480 ± 0.006

- A new suggestion: a test of $A_{LL} = K_{LL}$ prediction in the pion photo production need 1% accuracy for A_{LL}

Last week comment from Peter Kroll:
Twist-3 would be important for ALL in pion photo-production process

Dear Bogdan,

you asked me whether the observables ALL, KLL, ALS and
KLS for photoproduction of pions tell us also something
about the handbag approach, not only the WACS observables.

I presently checking this in detail; as for electroproduction
of pions the twist-3 contribution (which goes along with
the transversity GPDs) may also play an important
role for photoproduction. In any case we made already
attempts in our 2003 paper (signatures...) to check that.
However, as it turned out the contributions from the asymptotic
forms of the pion twist-3 distribution amplitudes canceled
exactly. Since in 2003 we did not know that the twist-3
contribution is the dominant one in electroproduction
of pions we gave up this idea.

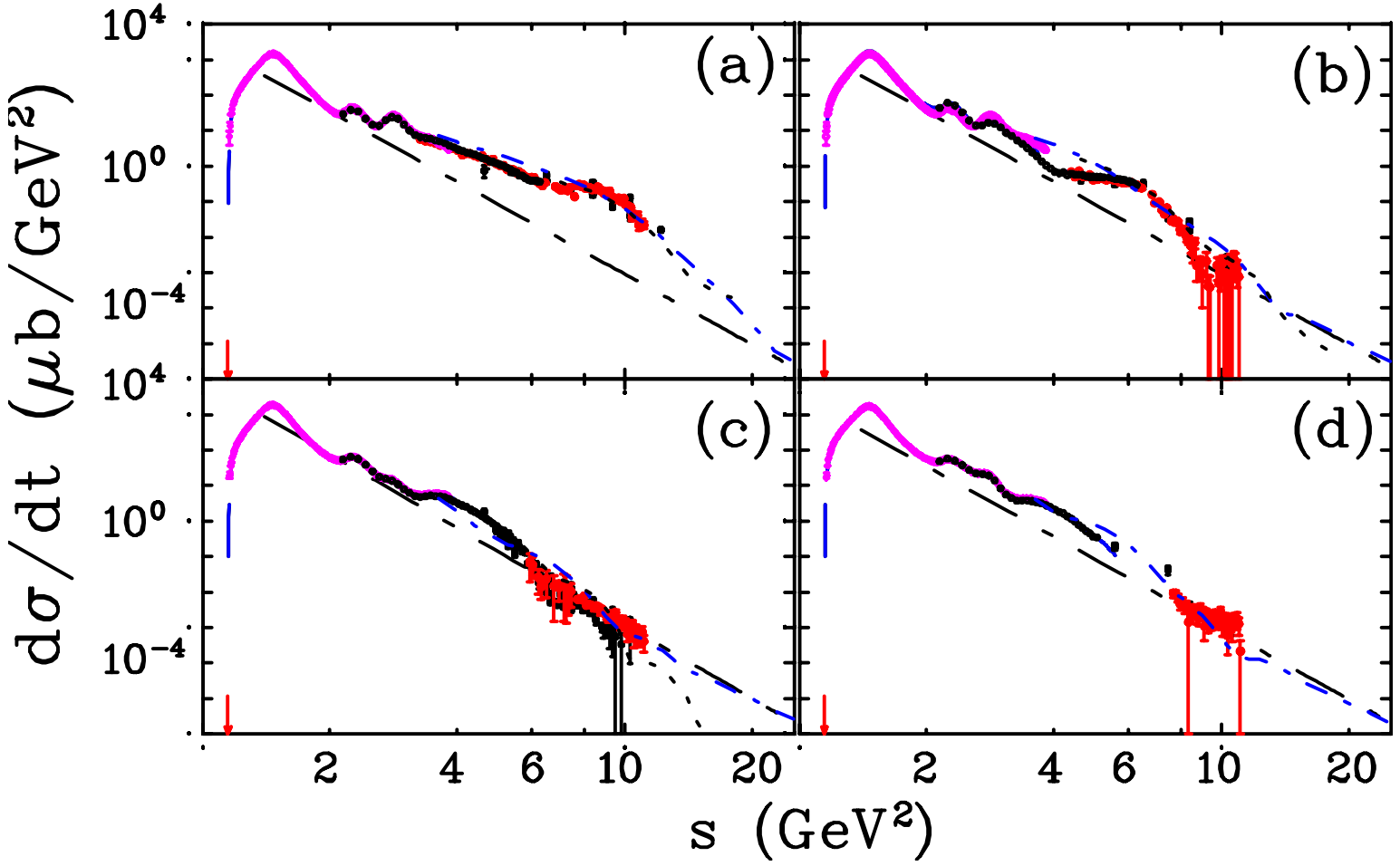
However, the situation has changed - we now know that twist-3
is an important contribution in electroproduction and
it seems plausible that this is also the case for photoproduction.
We will see what I can do with it.
By the way twist-3 does not contribute to WACS.

The WACS relations
ALL=KLL and ALS=-KLS
also hold for photoproduction at the twist-2 level.
Twist-3 contributions will change these relations.
Thus, for instance, from an experimentally observed difference
between ALL and KLL one learns about the size of the twist-3
contribution.

Best, Peter

The cross section

M. C. Kunkel, M. J. Amaryan et al, CLAS, arXiv:1712.10314v1



The cross section

P.Kroll et al, GPD based

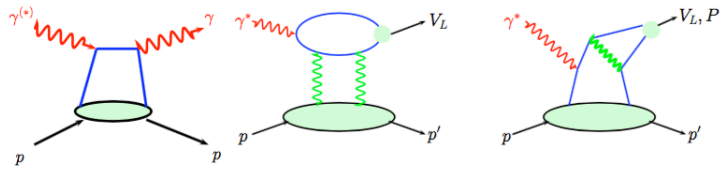


Fig. 4. Typical graphs for deeply virtual electroproduction for γ, V, P.

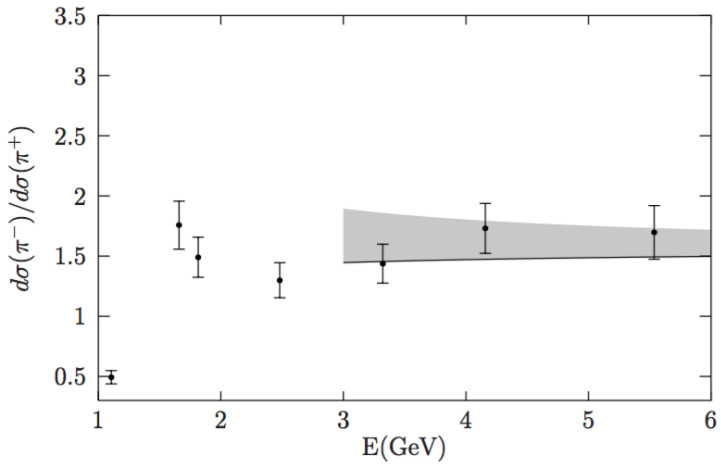


Fig. 4. The ratio of the $\gamma n \to \pi^- p$ and $\gamma p \to \pi^+ n$ cross sections versus photon beam energy E, at a CMS scattering angle of 90°. Data are taken from [31]. The solid line is the handbag prediction with the identification (48). The uncertainties due to target mass corrections [30] are indicated by the shaded band

The problem is the cross section ~100 times too low!

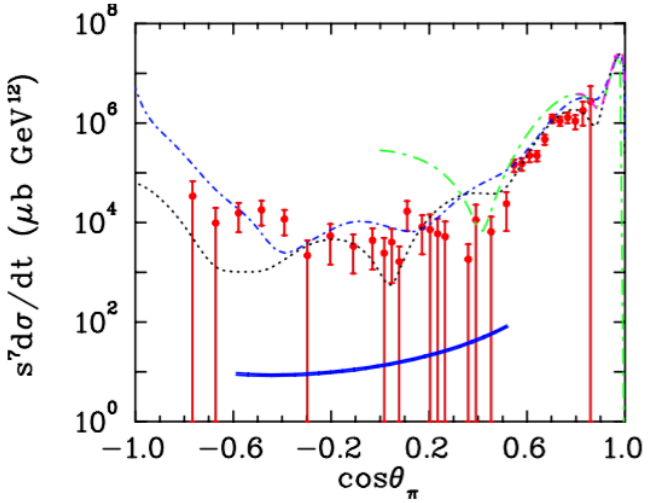


FIG. 6: (Color online) Differential cross section of π^0 photoproduction. The CLAS experimental data at $s = 11\text{GeV}^2$ are from the current experiment (red filled circles). The theoretical curves for the Regge fits are the same as in Fig. 4 and the Handbag model by Kroll *et al.* [12] (blue double solid line).

The recoil polarization

R.Gilman et al $\vec{\gamma}\, p \rightarrow \vec{p}\,\pi^{\circ}$

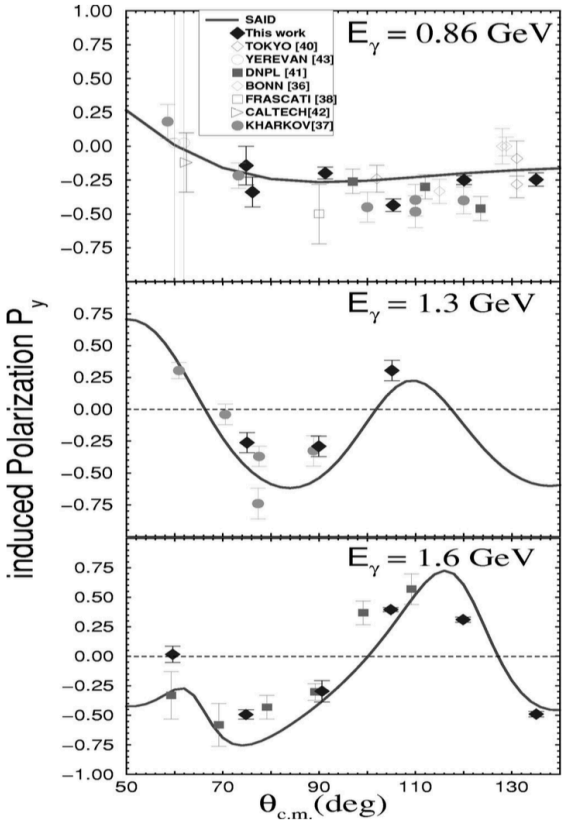


FIG. 15. Top to bottom: Angular distributions of induced polarization p_y in neutral pion photoproduction at E_γ=0.86 GeV, 1.3 GeV, and 1.6 GeV. The curve SAID [22] shown here is described in the text. Note that the JLab data were at energies of 0.8, 1.2, and 1.6 GeV as given in Table II.

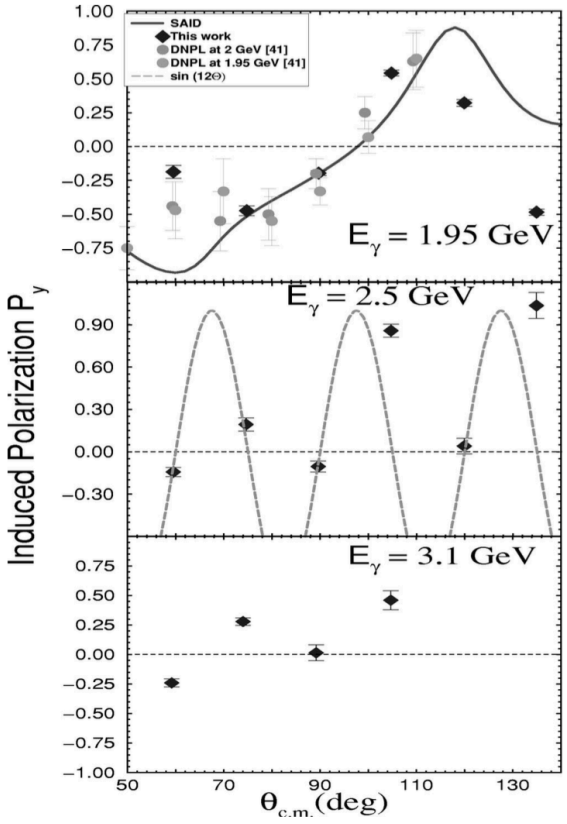


FIG. 16. Top to bottom: Angular distributions of induced polarization p_y in neutral pion photoproduction at E_γ=1.9 GeV, 2.5 GeV, and 3.1 GeV. The curve SAID [22] shown here is described in the text. The sin(12θ) curve at 2.5 GeV is drawn merely to illustrate the strong angular dependence. Note that the JLab data were at energies of 1.9, 2.5, and 3.1 GeV as given in Table II.

High mass ~ 2.4 GeV resonance?