Photoproduction of the $\Phi(1020)$ meson on neutron

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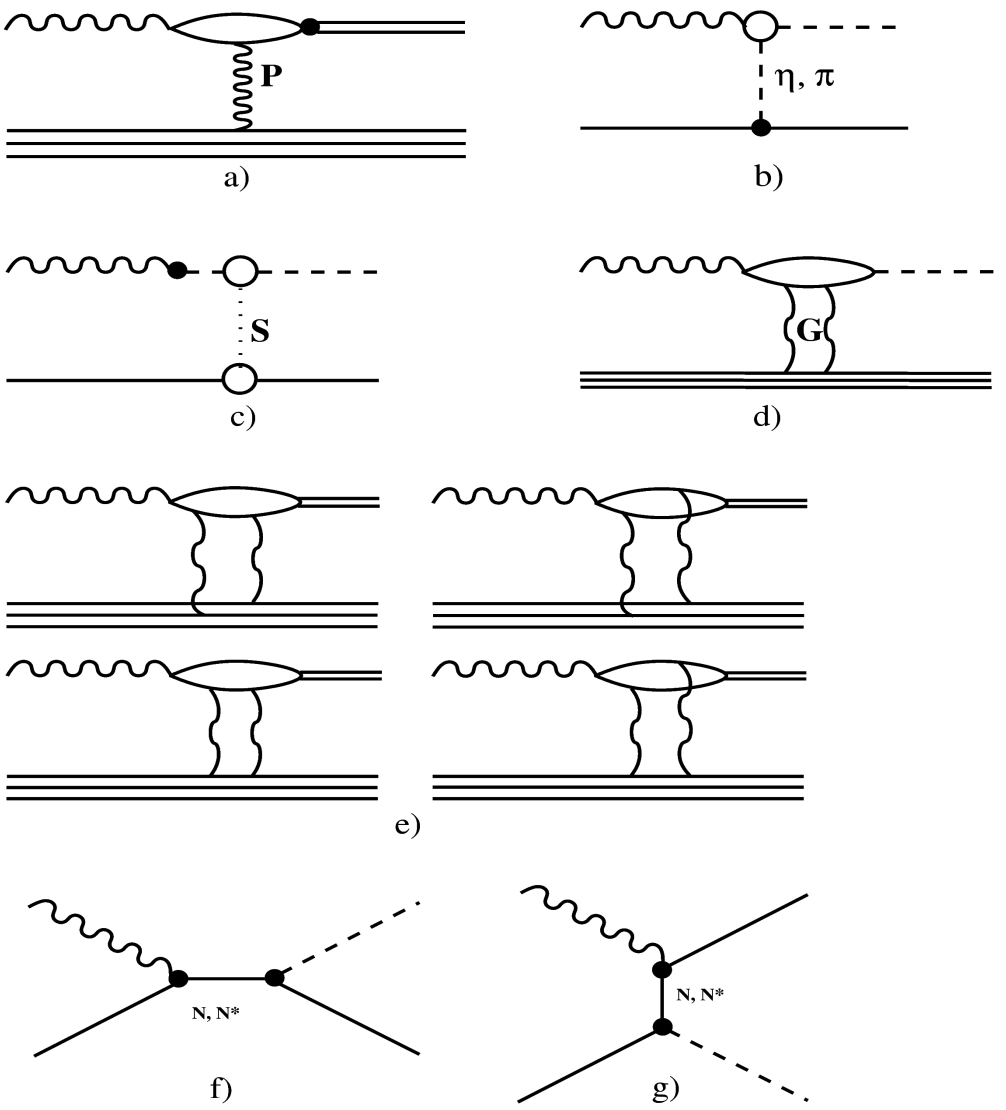
- Motivation
- Previous Results
- Ongoing analyses
- JLab g13 experiment
- Summary

Motivation: study of Φ production mechanism

- $\Phi(s\bar{s})$ => q's exchange between N is suppressed; unique system to study multi gluon exchange
- At W > 10 GeV mechanism via pomeron exchange describes well experimental data.
- At low energies (W < 2 GeV) this does not work => the mechanism of the Φ-photoproduction is not understood

  Possible mechanisms: pomeron exchange (with additional trajectories); scalar meson exchanges (f0(500),f0(980),a0(980)); glueball exchange; excitation of nuclear resonances; ϕ knockout from the nucleon; $\omega \rightarrow \phi$ transition; ...



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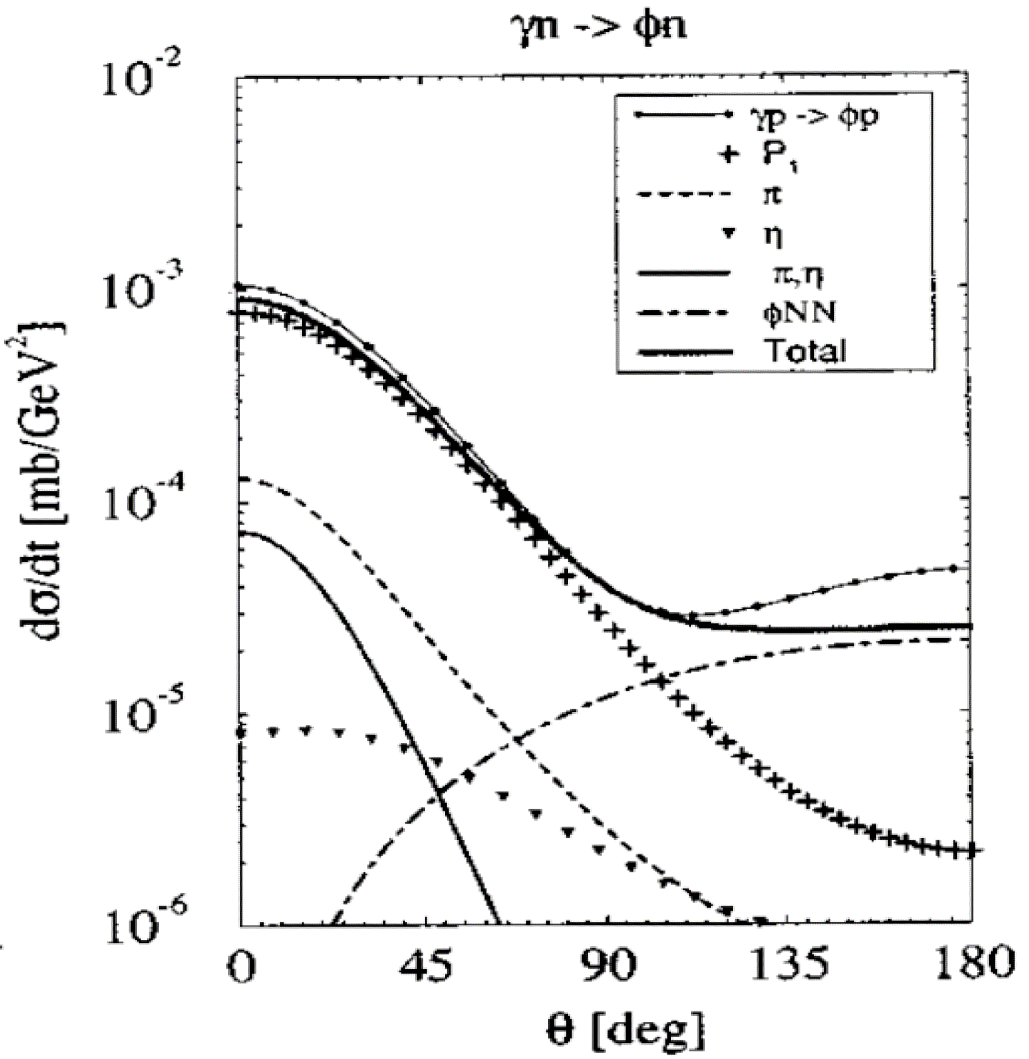

Diff. cs at Eγ = 2 GeV for pomeron exchange model

A.I.Titov et al. Phys. Rev. C 60 035205 (1999)

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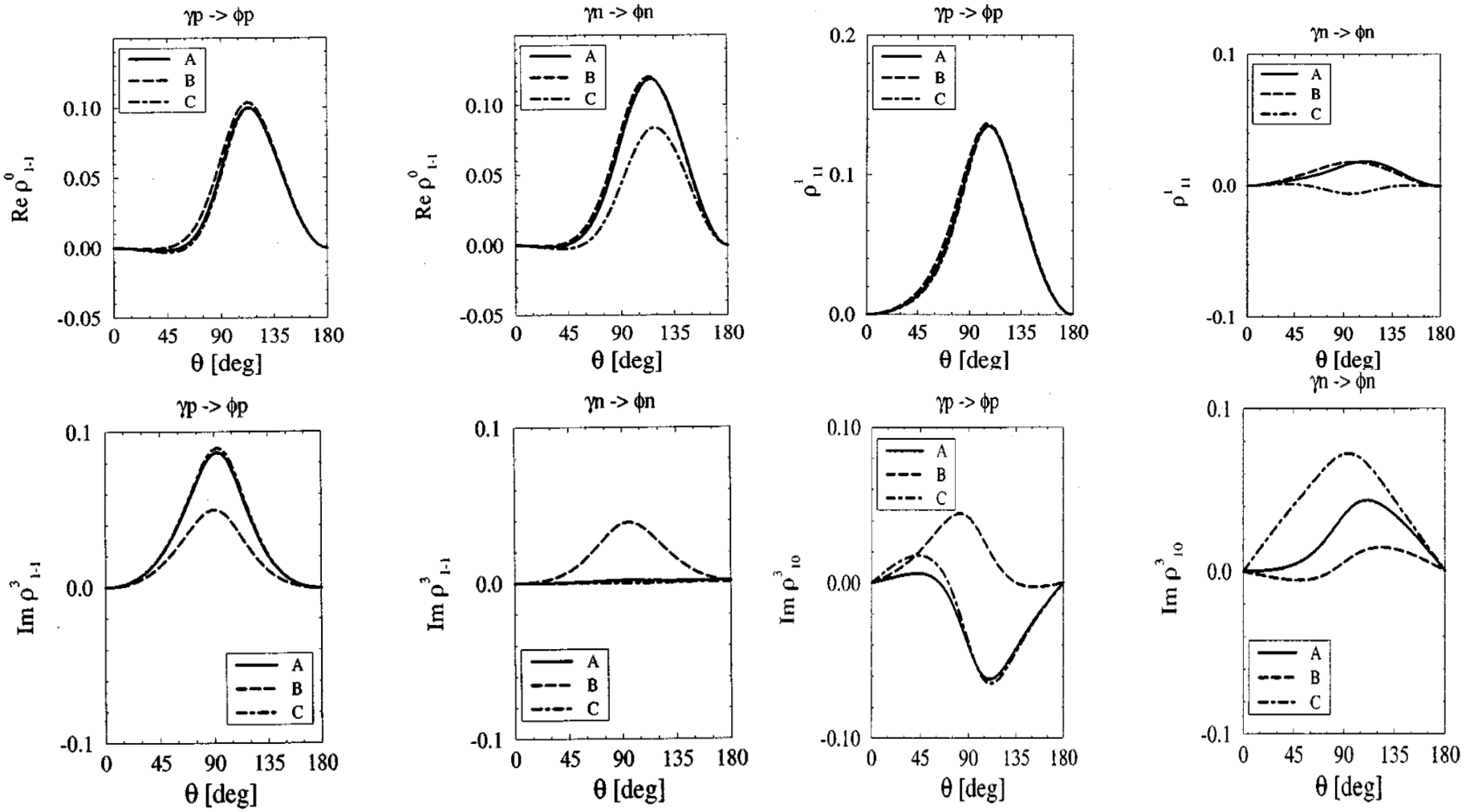
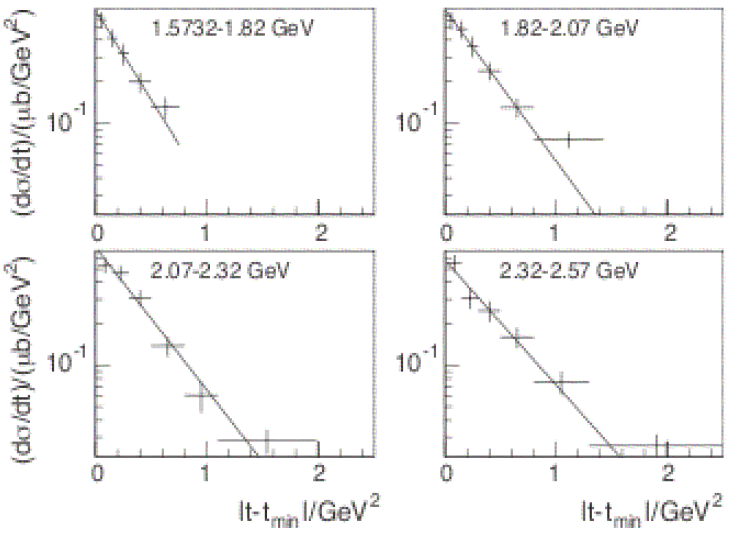
- The spin observables are sensitive to the of Φ-meson production and could help to distinguish different theoretical models.

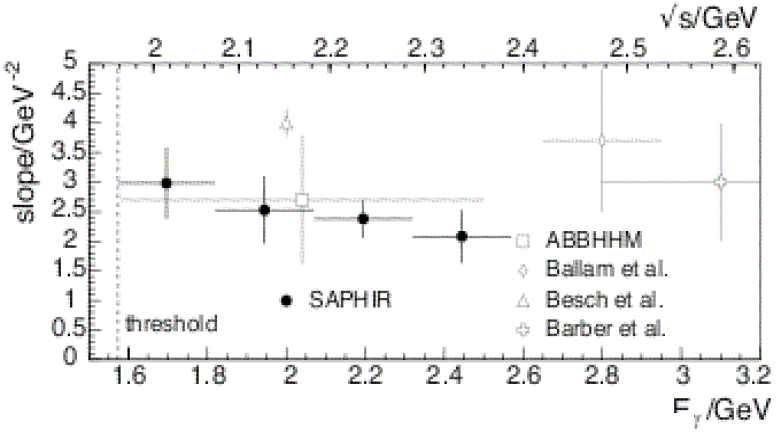


Sensitivity of the spin-denisity matrix elements for photoproduction on the proton and the neutron to three reaction mechanisms. A.I.Titov et al. Phys. Rev. C 60 035205 (1999)

Previous Analyses (SAPHIR, ELSA (Bonn, GERMANY))

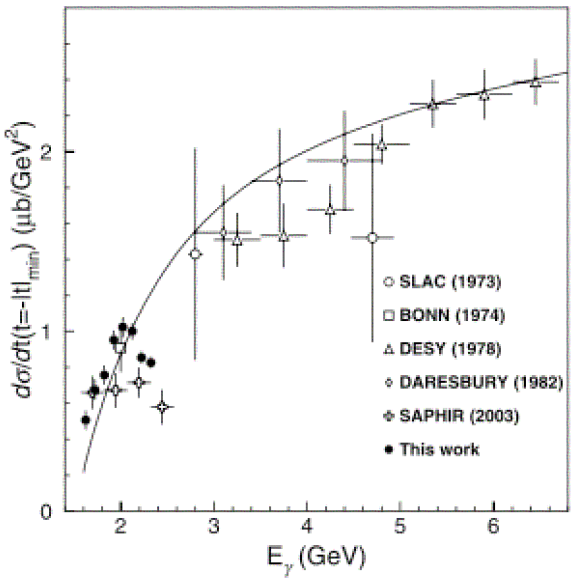
- LH target: $\gamma p \rightarrow \Phi p$ ($E\gamma$ < 2.6 GeV)
  - exponential drop of $d\sigma/dt$; angular distributions differs from the results at higher energies ⇒ excludes s-channel resonance contribution, so probably t-channel exchanges pi, eta exchange.

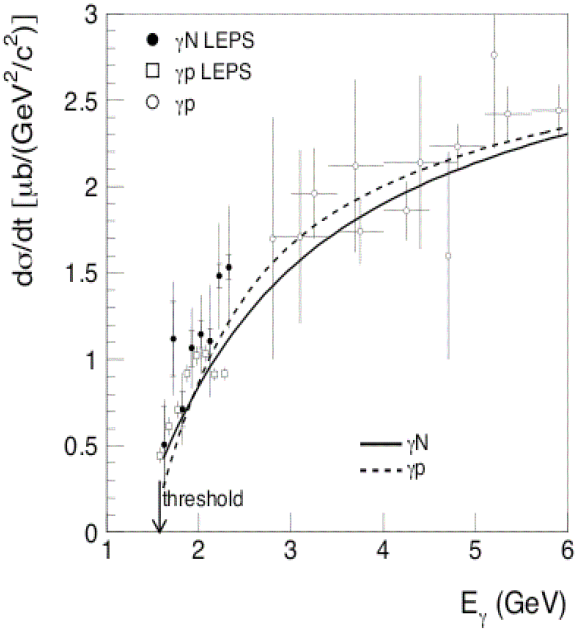


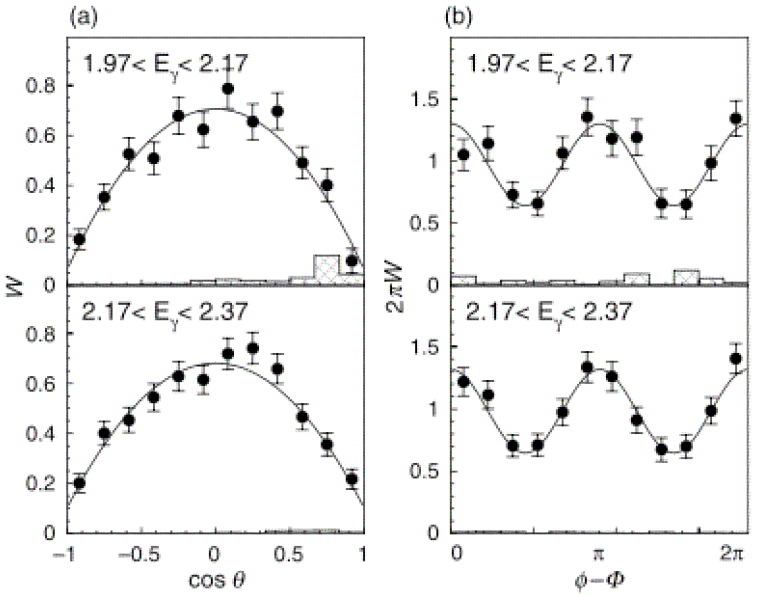


Previous Analyses (LEPS/SPRING-8 (JAPAN))

- LH, LD target linearly polarized photons (1.9 GeV < Eγ < 2.4 GeV)
  - Differential cs at t=-|tmin| from proton target increase non-monotonically as a function of Eγ and show local maximum at 2.GeV; The polar angle distribution W(cos th) behave similar as the result for protons;







W.C. Chang et al. arXiv:0907.1705v1

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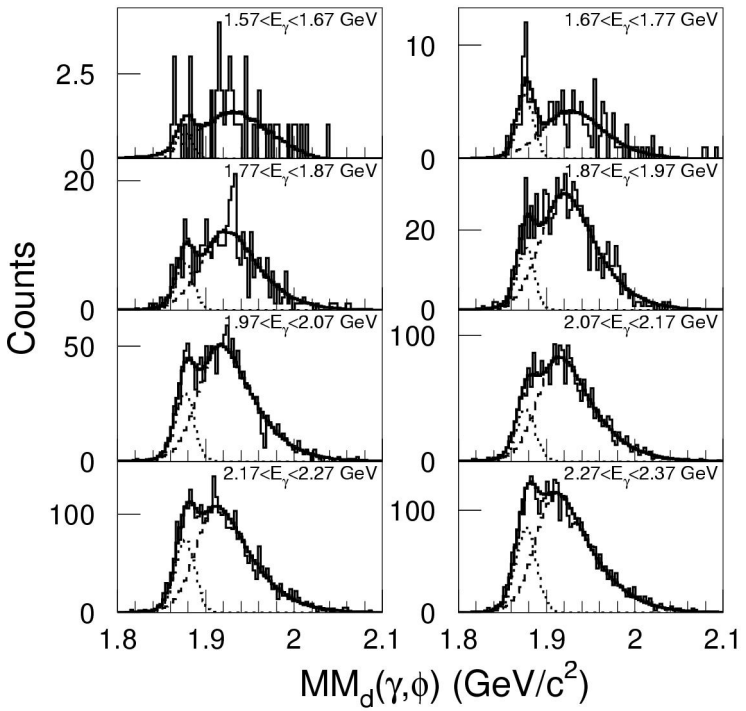

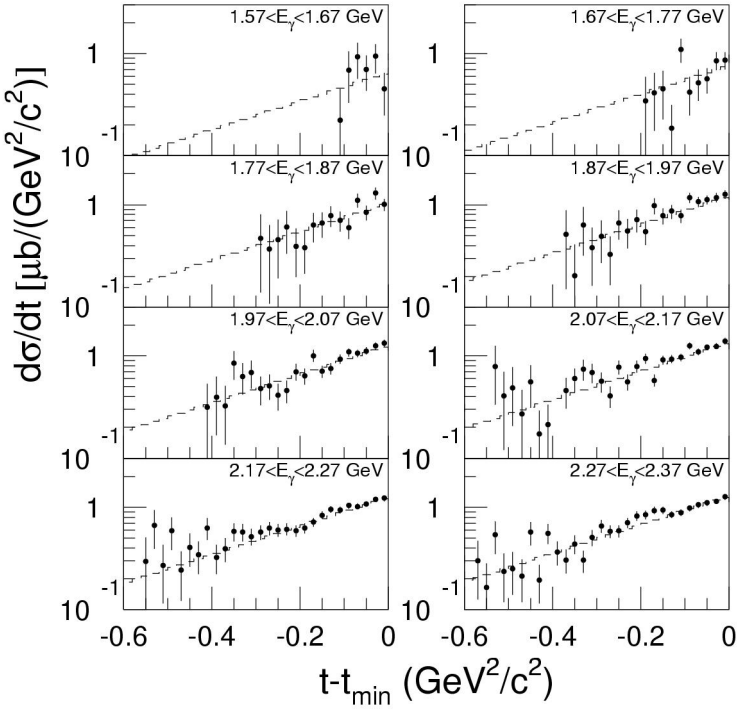

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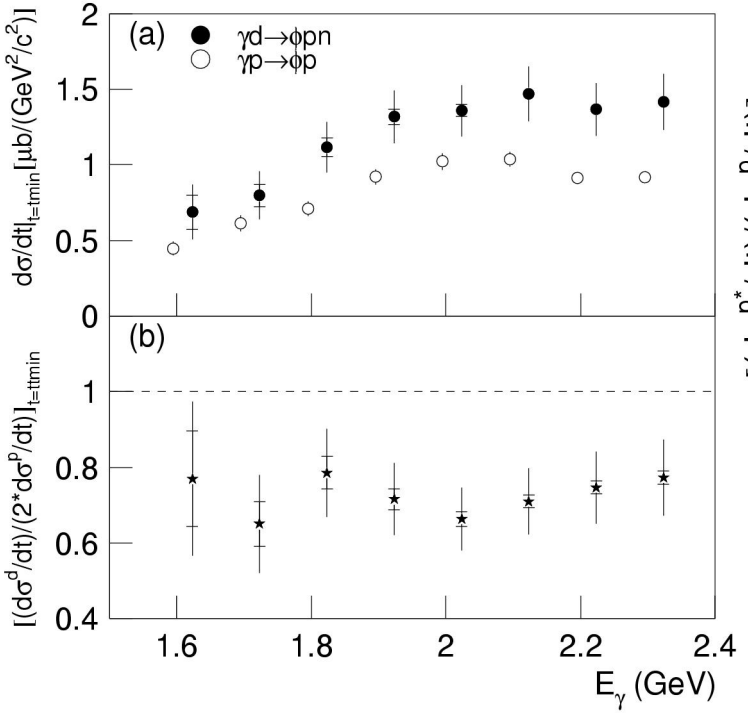

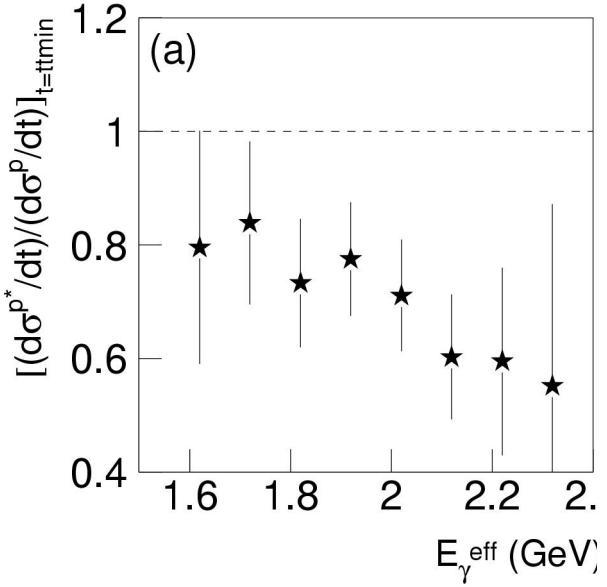

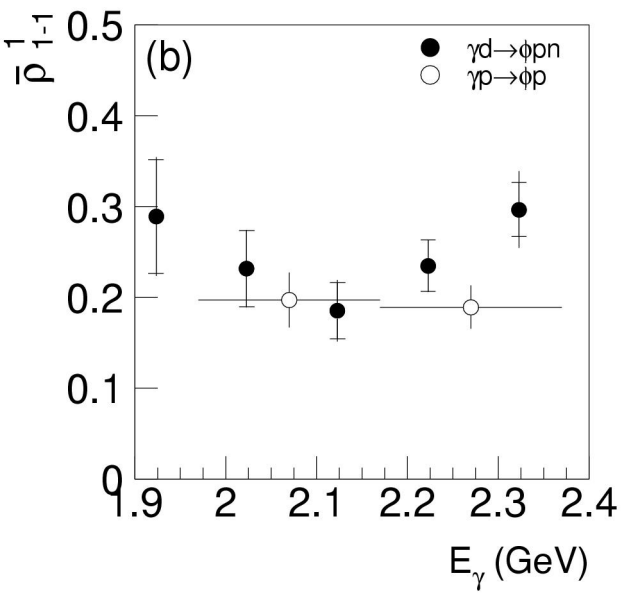

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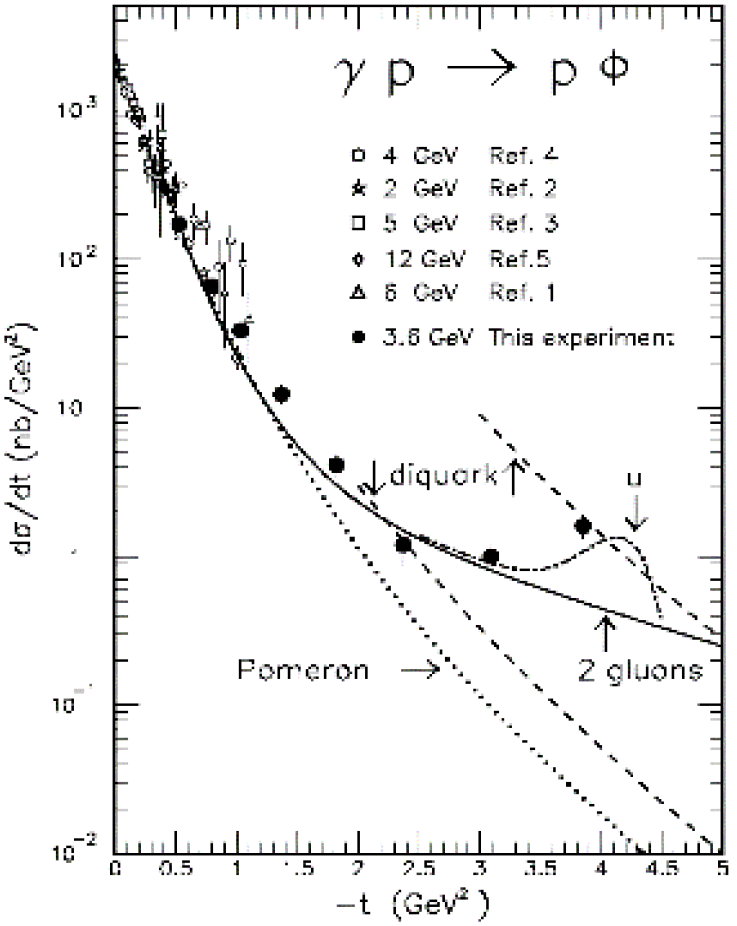
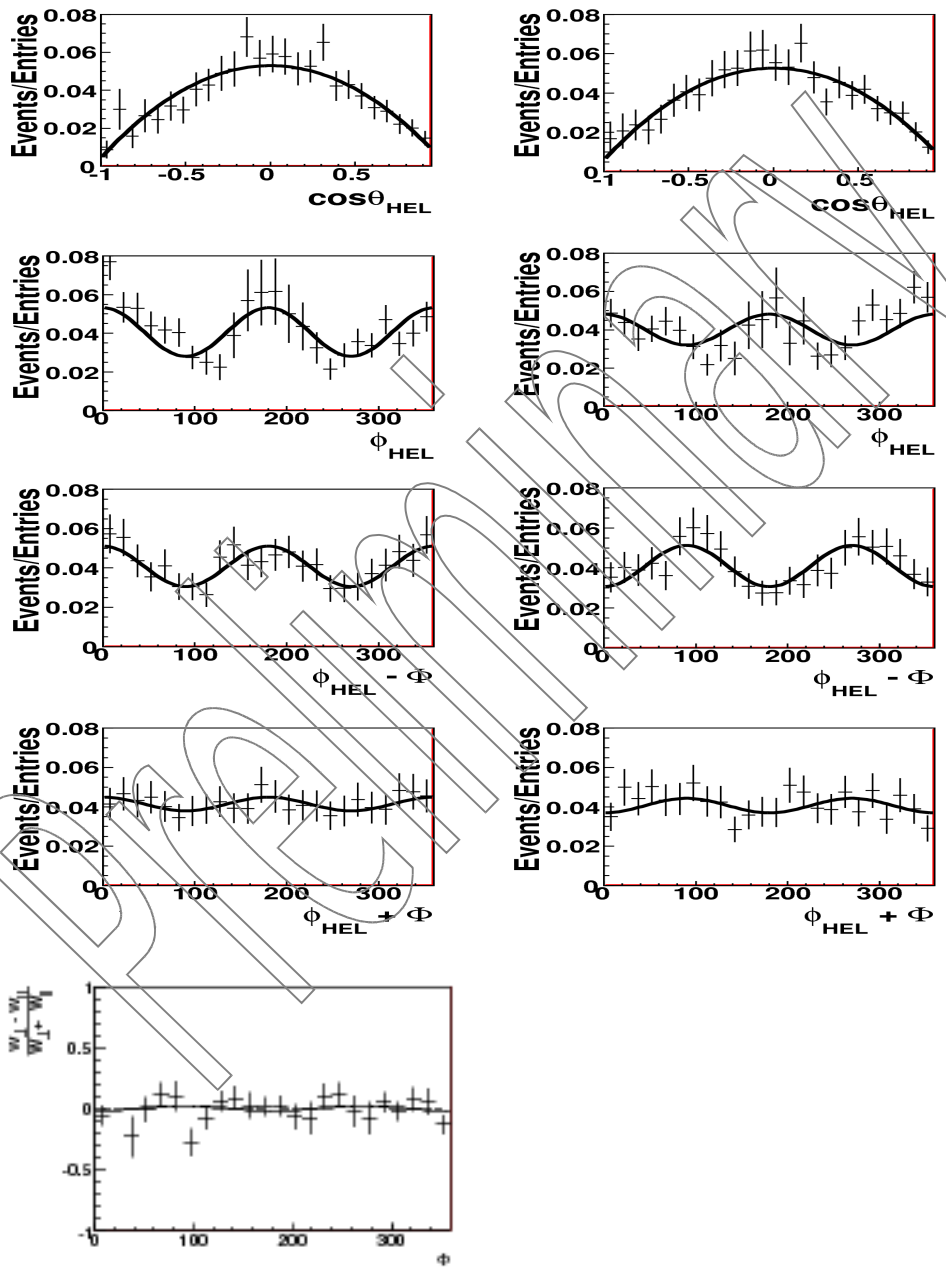
Previous Analyses (CLAS/JLab (USA))

- G1c: LH target ($\gamma p \rightarrow \Phi p$), good agreement with pomeron exchange for -t < 1 GeV2, for -t =1.8 GeV2 possible 2 gluon couples to to any quark in the proton and in Φ.

- G8: LH target ($\gamma p \rightarrow \Phi p$), linearly polarized photons



Preliminary results @ 2.1 GeV Coherent Peak



SDMEs for PARA and PERP $E_\gamma^{CP} = 2.1$ GeV data.

Number of bins: 30		
A2 conditions		
	$E_\gamma^{CP} = 2.1$ GeV	
SDME	PARA	PERP
ρ^1	0.0539±0.0214	0.0642±0.0227
ρ^2	-0.1342±0.0259	-0.1130±0.0262
ρ^3	0.1967±0.0392	0.2044±0.0375
ρ^4	0.0496±0.0405	0.0759±0.0385
Number of bins: 30		
ρ^5	0.0142± 0.0371	

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Jefferson Lab
Thomas Jefferson National Accelerator Facility

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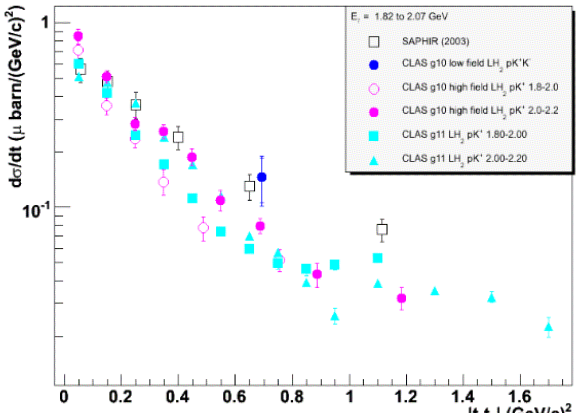
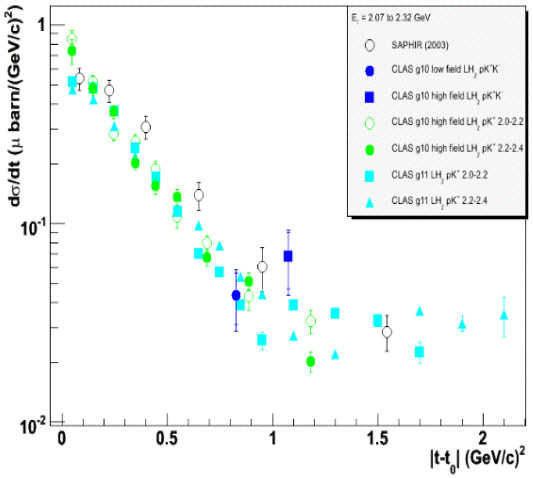
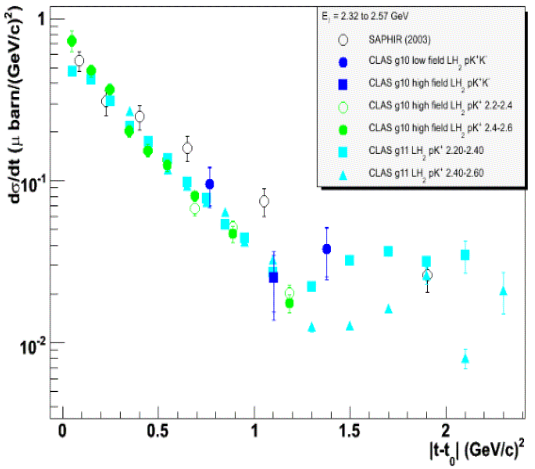
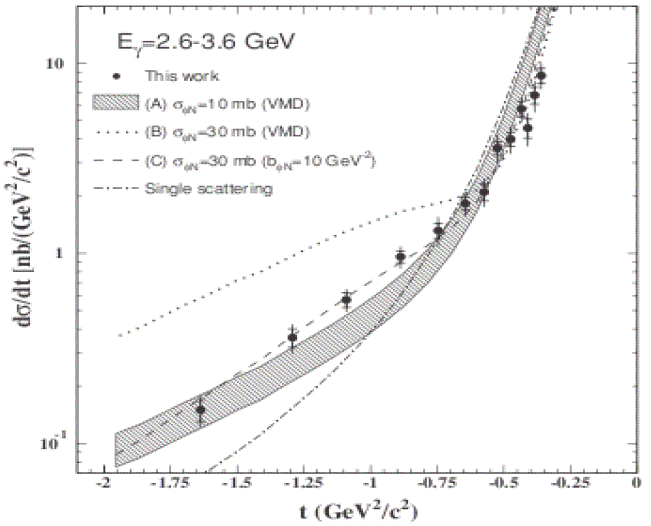
Previous Analyses (CLAS/JLab (USA))

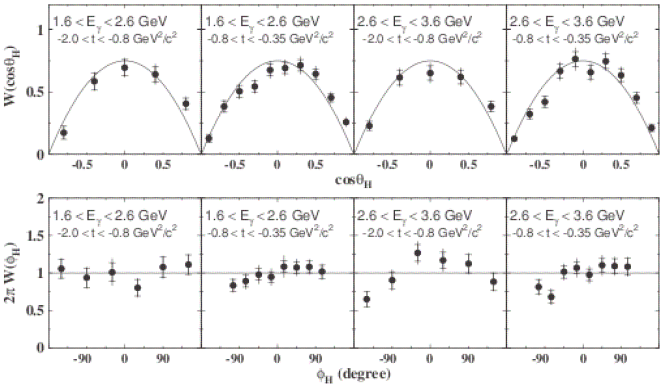
- G11 LH target ($\gamma p \to \Phi p$) and g10 LD target ($\gamma d \to \Phi d$), unpolarized photons
  - Differential cross section at large t exhibit a contribution from double scattering. The decay angular distributions follow the prediction from helicity conservation Disagreement between SAPHIR and g10/g11 cross section.











G13 experiment (CLAS/JLab (USA))

Data collected between October 2006 and June 2007

Circular Photons

- E_γ = 0.4 – 1.9 GeV
  - E_e = 2.0 GeV, polarization 84%
- E_γ = 0.5 – 2.5 GeV
  - E_e = 2.6 GeV, polarization 78%
- Trigger
  - two charged tracks
  - rate up to 10 kHz
- Statistics
  - $2 \cdot 10^{10}$ LD_2 events

Linear Photons

- E_e = 3.3 – 5.2 GeV
- E_γ = 1.1 – 2.3 GeV
  - six photon energy settings
  - polarization 70-90%
- Trigger
  - single charged track
  - rate 7-8 kHz
- Statistics
  - $3 \cdot 10^{10}$ LD_2 events

Summary

- No polarized Φ photoproduction data on the NEUTRON
- The g13 experiment can provide such a data
  - Advantages: huge statistic
  - Challenges: experiment used reversed magnetic field (positive particles were inbending) =>reduced acceptance for deuterons and K+
- Feasibility studies to extract density matrix elements for Φ photoproduction on the neutron are ongoing.