Analysis Meetinh

04/05/2019
(Group Meeting)

Zulkaida Akbar
University of Virginia

Outline

- JLAB-Hall B
- JLAB-Hall D
- SpinQuest
- SOM

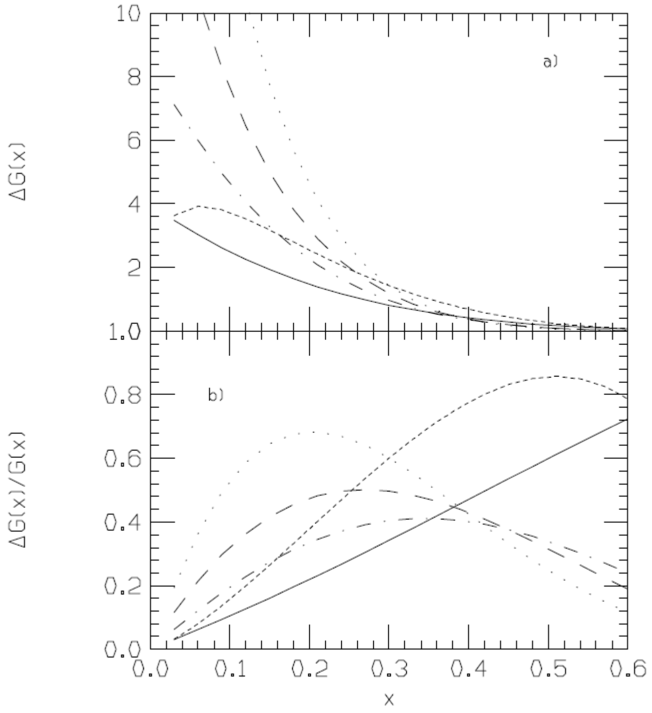
JLAB Hall B

- The machinery is set up at polar machine
- The machinery is set up at Jlab
- Scripts are available for 2pion/2kaon/1p-1k
  Final states analysis

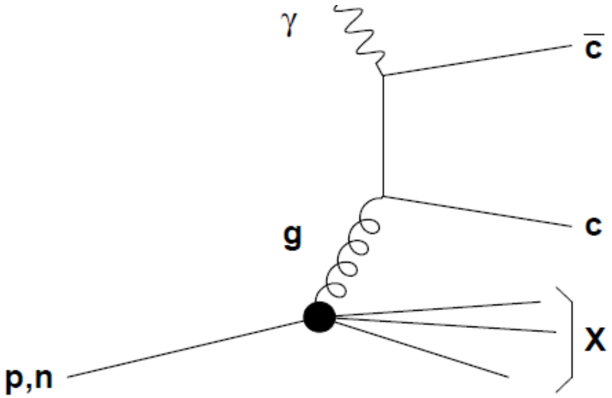
Physics

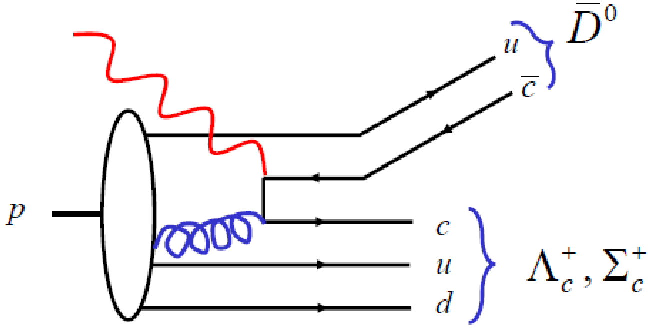
Probing Gluon Polarization:

Through g1 measurement (Model dependent)



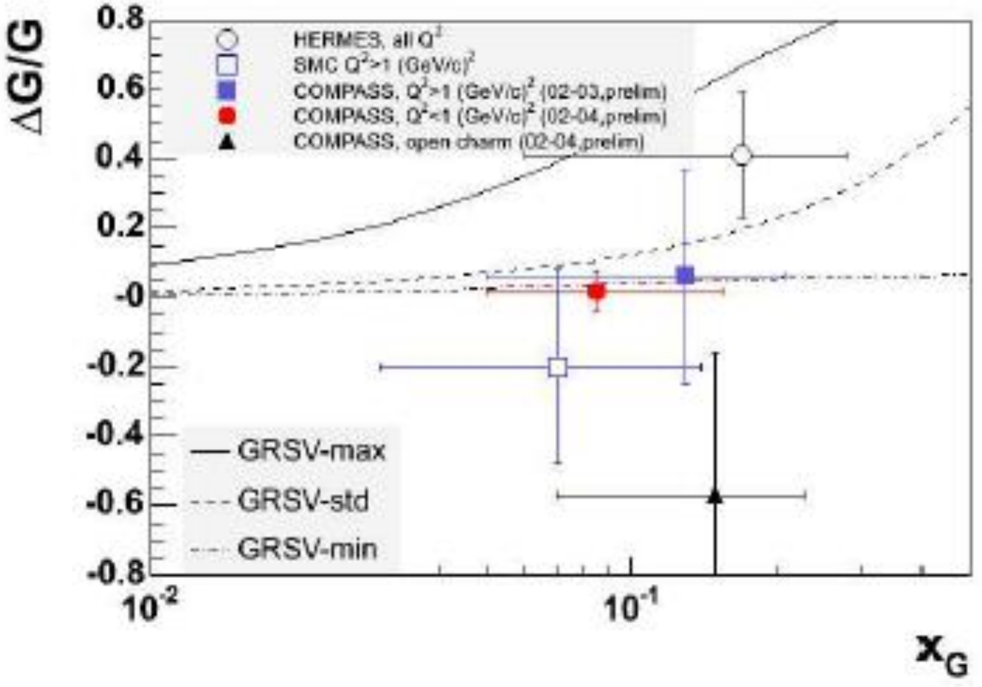
Open charm production (photon-gluon fusion)





Associated production?

Previous Measurement



2007 Paper

Theory

$$A_{cc}(k) = \frac{1}{P_t P_b f} \, \frac{N^{\uparrow\uparrow} - N^{\downarrow\uparrow}}{N^{\uparrow\uparrow} + N^{\downarrow\uparrow}} = \frac{\Delta\sigma_{\gamma p}(k)}{\sigma_{\gamma p}(k)}$$

$$\sigma_{\gamma p}(k) = \int_{x_{min}}^{1} g(x, Q^2) dx \int_{-1}^{1} \sigma(\hat{s}, \cos(\theta^*)) \; \epsilon(\hat{s}, \cos(\theta^*)) \; \beta \; d\cos(\theta^*)$$

$$\Delta\sigma_{\gamma p}(k) = \int_{x_{min}}^{1} \Delta g(x, Q^2) dx \int_{-1}^{1} \Delta\sigma(\hat{s}, \cos(\theta^*)) \; \epsilon(\hat{s}, \cos(\theta^*)) \; \beta \; d\cos(\theta^*)$$

The Asymmetry is proportional to the gluon polarization ${}^{\Delta g}/_{g}$

Channel & PID

$$D^0 \to K^- + \pi^+ \quad \text{and} \quad \bar{D}^0 \to K^+ + \pi^- \longrightarrow N^{D^0}/N^{c\bar{c}} = 1.23.$$

$$D^{*+} \to D^0 \pi_S^+ \to (K^- \pi^+)\, \pi_S^+$$

Do we only need to detect (reconstruct) one Meson?
Where is the ratio come from?

	D^+	D^0	D_s^+	Λ_c^+
produced	0.19	0.63	0.08	0.08
decay to μ^+	0.37	0.47	0.08	0.04
	D^-	$\bar{D}^0$	D_s^-	Λ_c^-
produced	0.21	0.71	0.06	0.02
decay to μ^-	0.40	0.53	0.05	0.01

$$\frac{\sigma(\gamma + N \to c\bar{c})}{\sigma(\gamma + N \to J/\psi)} \approx \frac{\sigma(\gamma + N \to KY)}{\sigma(\gamma + N \to \phi)} = \frac{4.2\,\mu b}{.4\,\mu b} \simeq 10 \pm 4$$

Valid near-ish the threshold, from E_γ=2 to 12 GeV

$$\frac{\sigma(\gamma + N \to c\bar{c})}{\sigma(\gamma + N \to J/\psi)} = \begin{cases} \dfrac{0.55\,\mu b}{.018\,\mu b} = 30 \pm 9 & \text{at } E_\gamma = 150\text{ GeV; } W = 17\text{ GeV} \\[2ex] \dfrac{60\,nb}{5.2\,nb} = 11 \pm 6 & \text{at } E_\gamma = 20\text{ GeV; } W = 6.1\text{ GeV} \end{cases}$$

Beam & Target

Beam: Circularly-polarized, 9 GeV Photon

		NH_3	butanol	d-butanol	^{6}LiD
Polarization of the nuclei	P_N	H: 0.90	H: 0.90	D: 0.50	D: 0.510 H: 0.992 ^{6}Li: 0.493 ^{7}Li: 0.914
Polarization of the nucleons	P_n	0.90	0.90	0.463	0.472 in D 0.992 in H 0.427 in ^{6}Li 0.573 in ^{7}Li
(fractional) dilution factor	f	0.176	0.135	0.238	D: 0.2481 H: 0.0003 ^{6}Li: 0.2375 ^{7}Li: 0.0056
Effective polarization	P_{eff}	0.158	0.122	0.110	0.222
Density (10^3 kg/m^3)	ρ	0.85	0.99	1.10	0.84
Packing factor	κ	0.60	0.60	0.60	0.55
Figure of merit (kg/m^3)	F	12.7	8.8	8.0	22.8

Rate & Kinematic

Reinhard study:

Rate Estimates

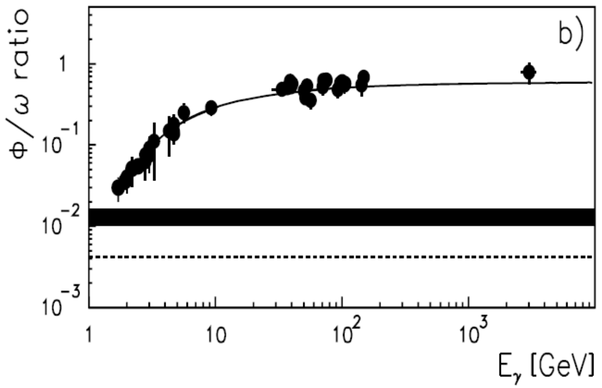
$$N_{detect} = N_{\gamma}\sigma_{tot}\left(\frac{l\rho t N_A}{A}\right)(B.F.)\varepsilon\kappa$$

- Use $N_{\gamma}=10^8/s$; target length = 30 cm
- Use kaon decay factor of $\kappa \approx 0.5$
- Get N_{detect}/σ_{tot} = (451 events/hr/nb)x$B.F.$x$\varepsilon\kappa$
- .29 events/hr/nb $\gamma\, p \rightarrow \Lambda_c^+\, \bar{D}^0$
- .31 events/hr/nb $\gamma\, p \rightarrow \Sigma_c^+\, \bar{D}^0$
- .86 events/hr/nb $\gamma\, p \rightarrow \Sigma_c^{++}\, D^-$

- Exclusive
- No K/Pi separation

Physics

- OZI rule is strongly violated especially in Photoproduction



Ratio from the photoproduction

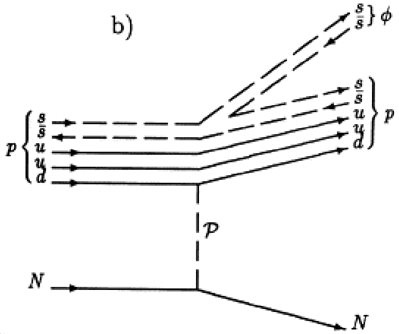
Ratio from the hadroproduction

Ratio from the SU(3) mixing

- This could be an indication of the non-negligible strangeness content in the nucleon or non-zero strangeness in the Nucleon-wave-function

$$|p\rangle = A|[uud]^{1/2}\rangle + B\Big\{a_0|[[uud]^{1/2} \otimes [s\bar{s}]^0]^{1/2}\rangle + a_1|[[uud]^{1/2} \otimes [s\bar{s}]^1]^{1/2}\rangle\Big\}$$

- If this admixture exist, this can contribute to the phi production through a “direct knockout” process



- Recent hydro dynamical simulations on core-collapse supernova (CCSN) require non-zero strangeness content in the nucleon (and non-zero strange helicity content) to produce successful explosion

The Role of Nucleon Strangeness in Supernova Explosions

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[2] *Department of Physics, Seattle University, Seattle, Washington 98122, USA*
(Dated: July 19, 2018)

- Parity-violating electron scattering experiment indicate the strangeness content in the nucleon.

Evidence for Strange Quark Contributions to the Nucleon's Form Factors at $Q^2 = 0.108(\mathrm{GeV/c})^2$

F. E. Maas,[1,*] K. Aulenbacher,[1] S. Baunack,[1] L. Capozza,[1] J. Diefenbach,[1] B. Gläser,[1] T. Hammel,[1] D. von Harrach,[1] Y. Imai,[1] E.-M. Kabuß,[1] R. Kothe,[1] J. H. Lee,[1] A. Lorente,[1] E. Schilling,[1] D. Schwaab,[1] M. Sikora,[1] G. Stephan,[1] G. Weber,[1] C. Weinrich,[1] I. Altarev,[2] J. Arvieux,[3] M. El-Yakoubi,[3] R. Frascaria,[3] R. Kunne,[3] M. Morlet,[3] S. Ong,[3] J. van de Wiele,[3] S. Kowalski,[4] B. Plaster,[4] R. Suleiman,[4] and S. Taylor[4]

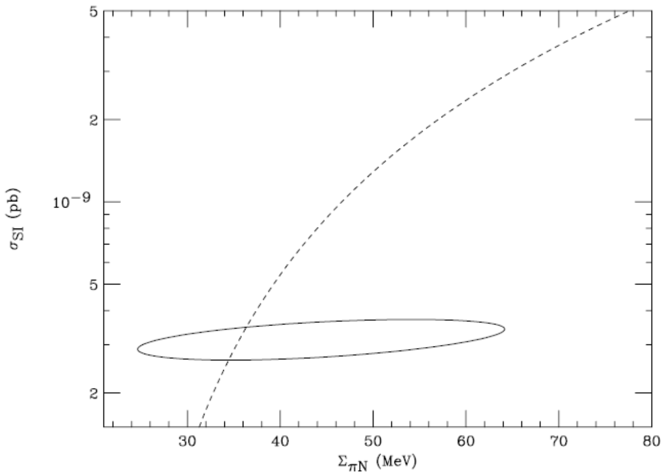
Strange Quark Contributions to Parity-Violating Asymmetries in the Forward G0 Electron-Proton Scattering Experiment

D. S. Armstrong,[1] J. Arvieux,[2] R. Asaturyan,[3] T. Averett,[1] S. L. Bailey,[1] G. Batigne,[4] D. H. Beck,[5] E. J. Beise,[6] J. Benesch,[7] L. Bimbot,[2] J. Birchall,[8] A. Biselli,[9] P. Bosted,[7] E. Boukobza,[2,7] H. Breuer,[6] R. Carlini,[7] R. Carr,[10] N. Chant,[6] Y.-C. Chao,[7] S. Chattopadhyay,[7] R. Clark,[9] S. Covrig,[10] A. Cowley,[6]

Precision Measurements of the Nucleon Strange Form Factors at $Q^2 \sim 0.1\,\mathrm{GeV}^2$

A. Acha,[1] K. A. Aniol,[2] D. S. Armstrong,[3] J. Arrington,[4] T. Averett,[3] S. L. Bailey,[3] J. Barber,[5] A. Beck,[6] H. Benaoum,[7] J. Benesch,[8] P. Y. Bertin,[9] P. Bosted,[8] F. Butaru,[10] E. Burtin,[11] G. D. Cates,[12] Y.-C. Chao,[8] J.-P. Chen,[8] E. Chudakov,[8] E. Cisbani,[13] B. Craver,[12] F. Cusanno,[13] R. De Leo,[14] P. Decowski,[15] A. Deur,[8]

- An accurate determination of the strange quark sigma term is of principle importance in the reduction of hadronic uncertainties in the predicted dark matter cross sections for a wide range of models.



Strange quark content of the nucleon and dark matter searches

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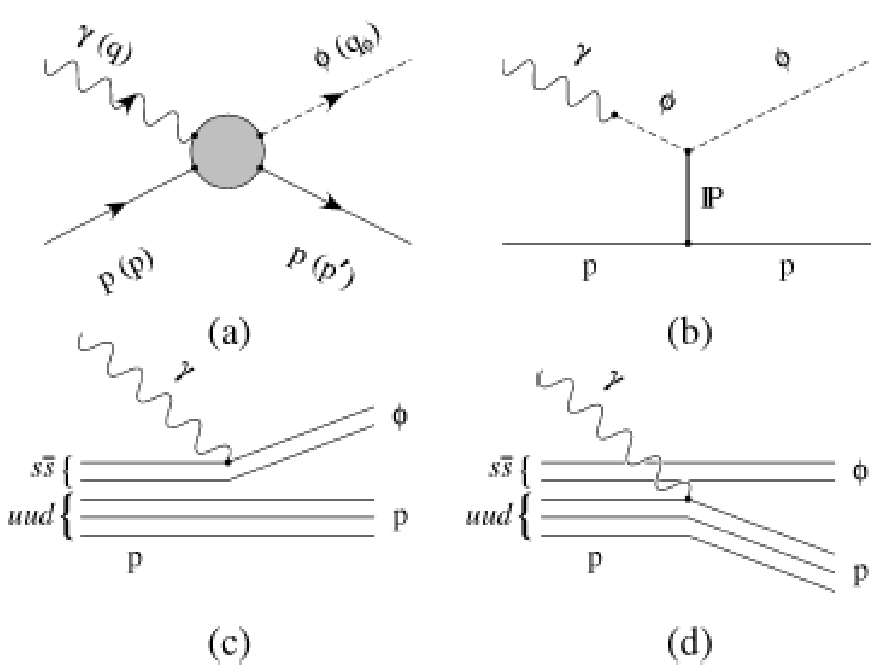
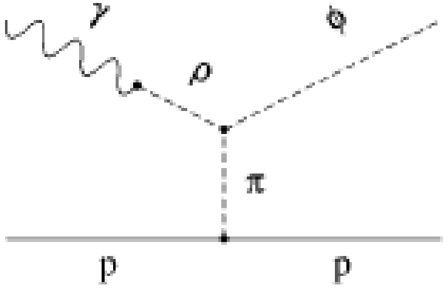
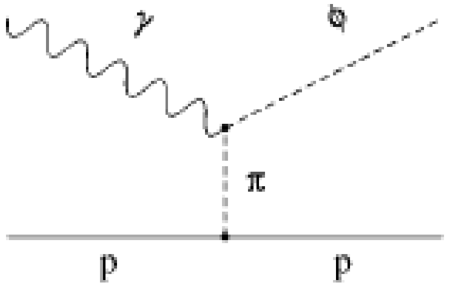
Theory







Theory

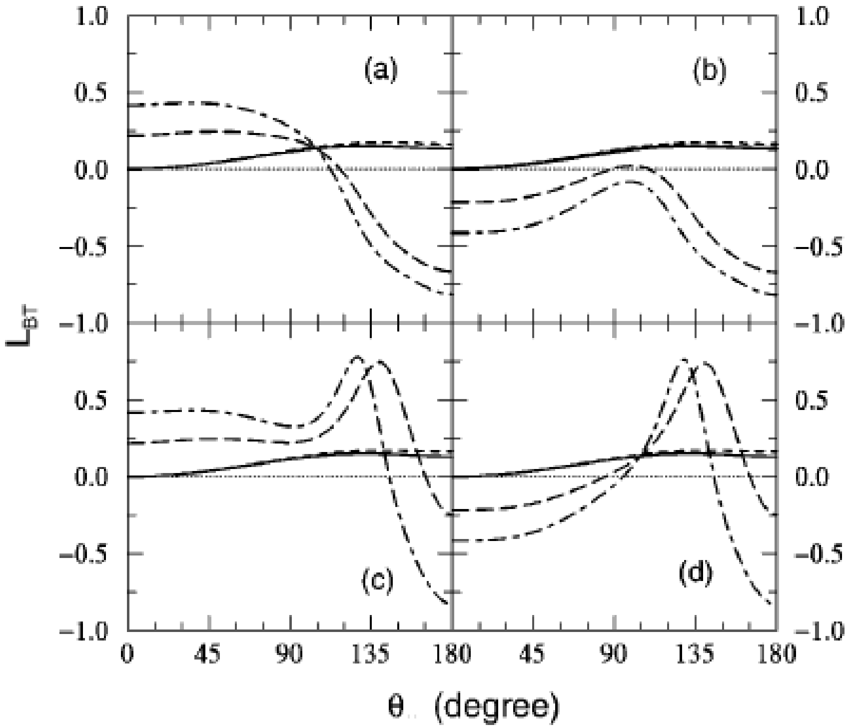


FIG. 4. The longitudinal asymmetry $\mathcal{L}_{\mathrm{BT}}(\theta)$ at $W = 2.155$ GeV with $B^2 = 0\%$, i.e., the VDM and OPE (solid lines), 0.25% (dashed lines), and 1% (dot-dashed lines) assuming that $|a_0| = |a_1| = 1/\sqrt{2}$. The dotted line, which nearly overlaps the solid line, is the prediction of pure VDM. The phases of a_0 and a_1 for (a), (b), (c), and (d) are $(+,+)$, $(-,+)$, $(+,-)$, and $(-,-)$, respectively.

$$\mathcal{L}_{\mathrm{BT}} \equiv \frac{|H_{u,u;+,+}|^2 - |H_{u,u;+,-}|^2}{|H_{u,u;+,+}|^2 + |H_{u,u;+,-}|^2},$$

Previous Measurement

No Previous measurement available

Channel & PID & RATE

$$\gamma p \to p\varphi \to pKK$$

DIRC is already installed and commissioning

We don't need to worry about rate. The minimum beam time is calculated based on the charm production

Beam & Target

Beam: Circularly-polarized, 9 GeV Photon
Target: Longitudinally polarized

- Y(2175) observed by BABAR from the φf invariant mass
- It's nature, spin and parity is still unknown
- However,

KK, K^*K^*, $K(1460)K, h_1(1380)\eta$ are forbidden. For the 2^3D_1 $s\bar{s}$ scenario discussed in this present paper, however, the decay modes of $Y(2175) \to KK$, K^*K^*, $K(1460)K, h_1(1380)\eta$ should be visible and the corresponding decay widths are large in contrast to the hybrid

- And we have a support theory to deal with the background

Double-Regge Exchange Limit for the $\gamma p \to K^+K^-p$ Reaction

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M. R. Pennington,[2] D. Schott,[5] and A. P. Szczepaniak[2,3,4]
(Joint Physics Analysis Center)
[1]*Department of Physics, Peking University, Beijing 100871, China*
[2]*Theory Center, Thomas Jefferson National Accelerator Facility, Newport News, VA 23606*
[3]*Center for Exploration of Energy and Matter, Indiana University, Bloomington, IN 47403*
[4]*Physics Department, Indiana University, Bloomington, IN 47405*
[5]*Department of Physics, The George Washington University, Washington, DC 20052*
(Dated: June 14, 2018)

We apply the generalized Veneziano model (B_5 model) in the double-Regge exchange limit to the $\gamma p \to K^+K^-p$ reaction. Four different cases defined by the possible combinations of the signature factors of leading Regge exchanges ($(K^*, a_2/f_2)$, $(K^*, \rho/\omega)$, $(K_2^*, a_2/f_2)$, and $(K_2^*, \rho/\omega)$) have been simulated through the Monte Carlo method. Suitable event candidates for the double-Regge exchange high-energy limit were selected employing *Van Hove* plots as a better alternative to kinematical cuts in the K^+K^-p Dalitz plot. In this way we predict and analyze the double-Regge contribution to the K^+K^-p Dalitz plot, which constitutes one of the major backgrounds in the search for strangeonia, hybrids and exotics using $\gamma p \to K^+K^-p$ reaction. We expect that data currently under analysis, and that to come in the future, will allow verification of the double-Regge behavior and a better assessment of this component of the amplitude.

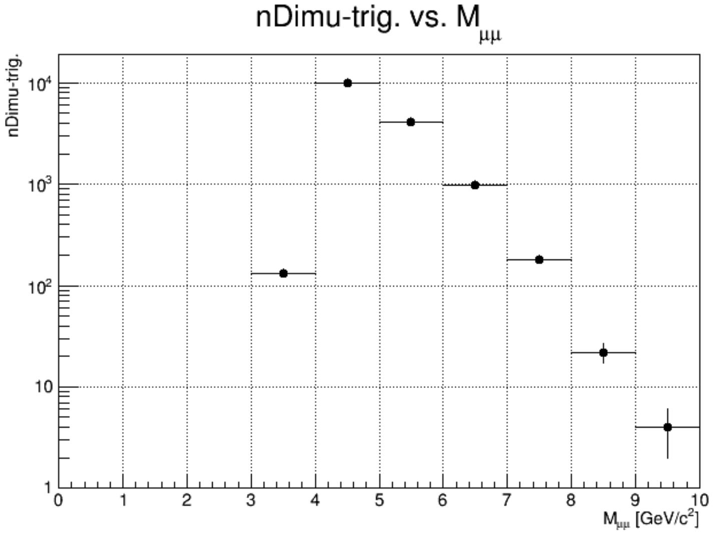
Outlook

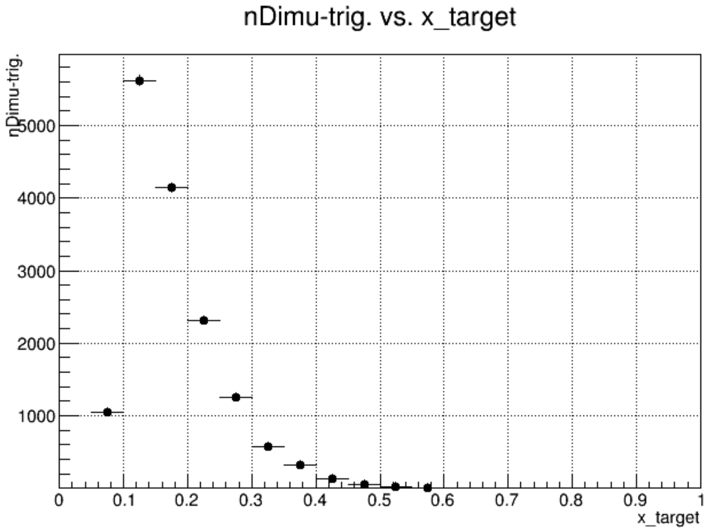
- Phi-photoproduction with deuteron target
- Talk to Reinhard?
- GlueX-Panda Workshop

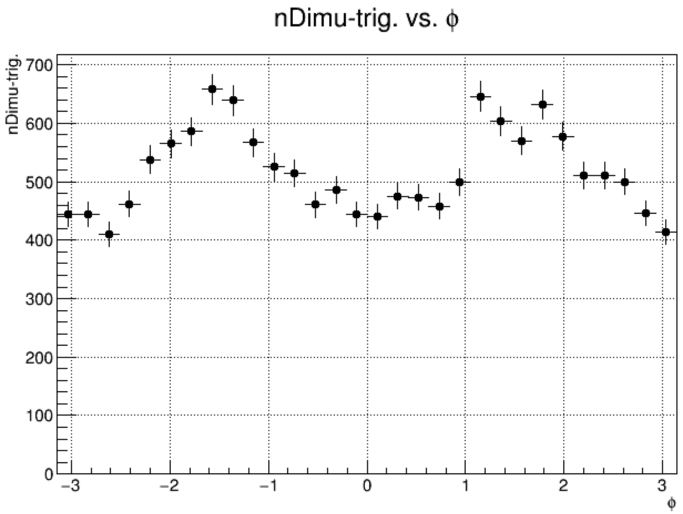
SpinQuest analysis

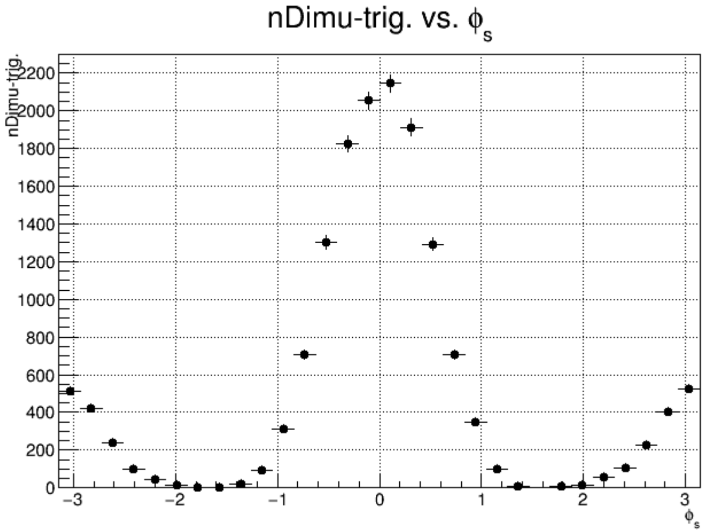
- First attempt of the Sivers-asymmetry extraction using MC events
- Job submitted at grid
- Next step: Understand acceptance and phi-asymmetry correction
- Require more man power to speed up the software preparation

Monte Carlo



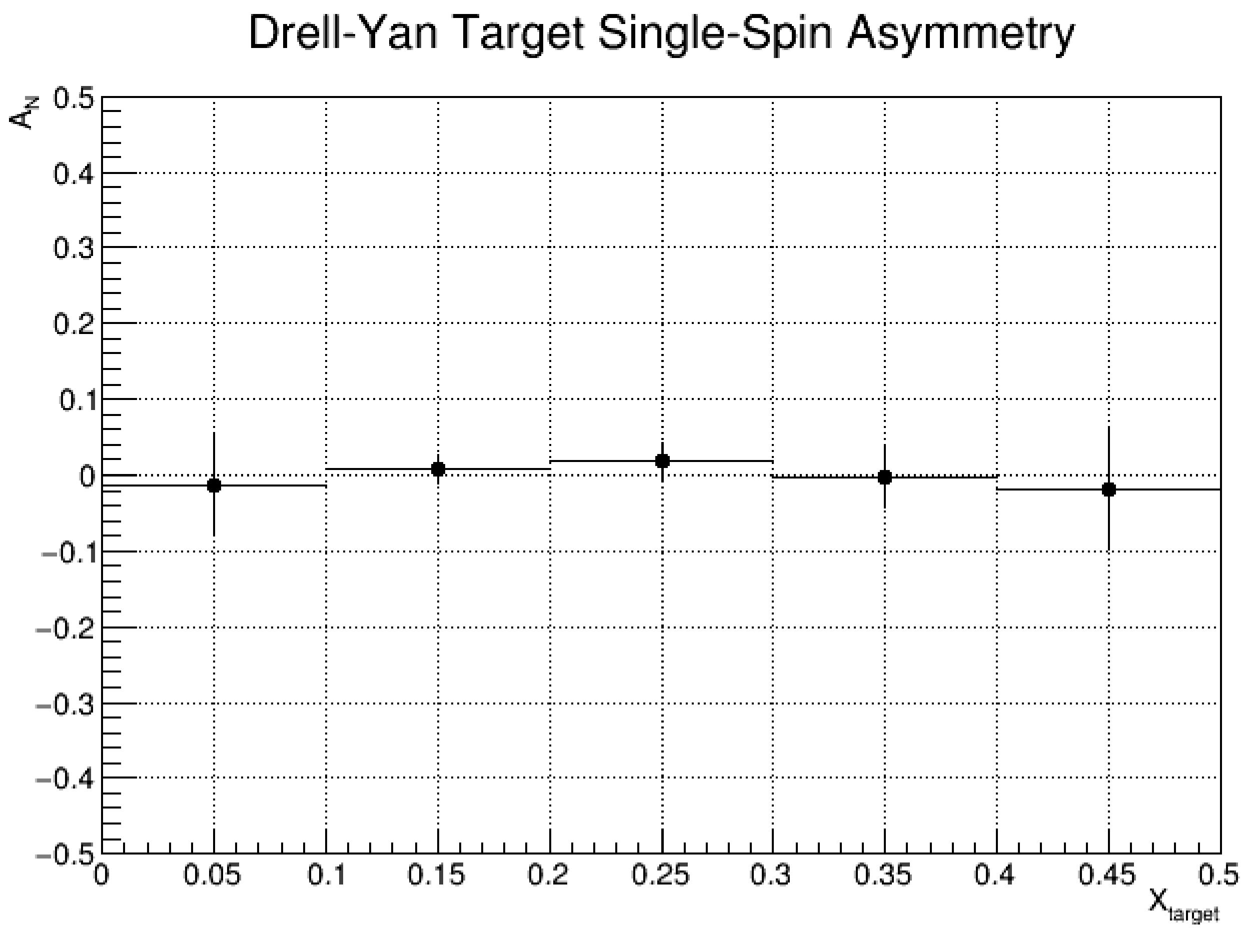




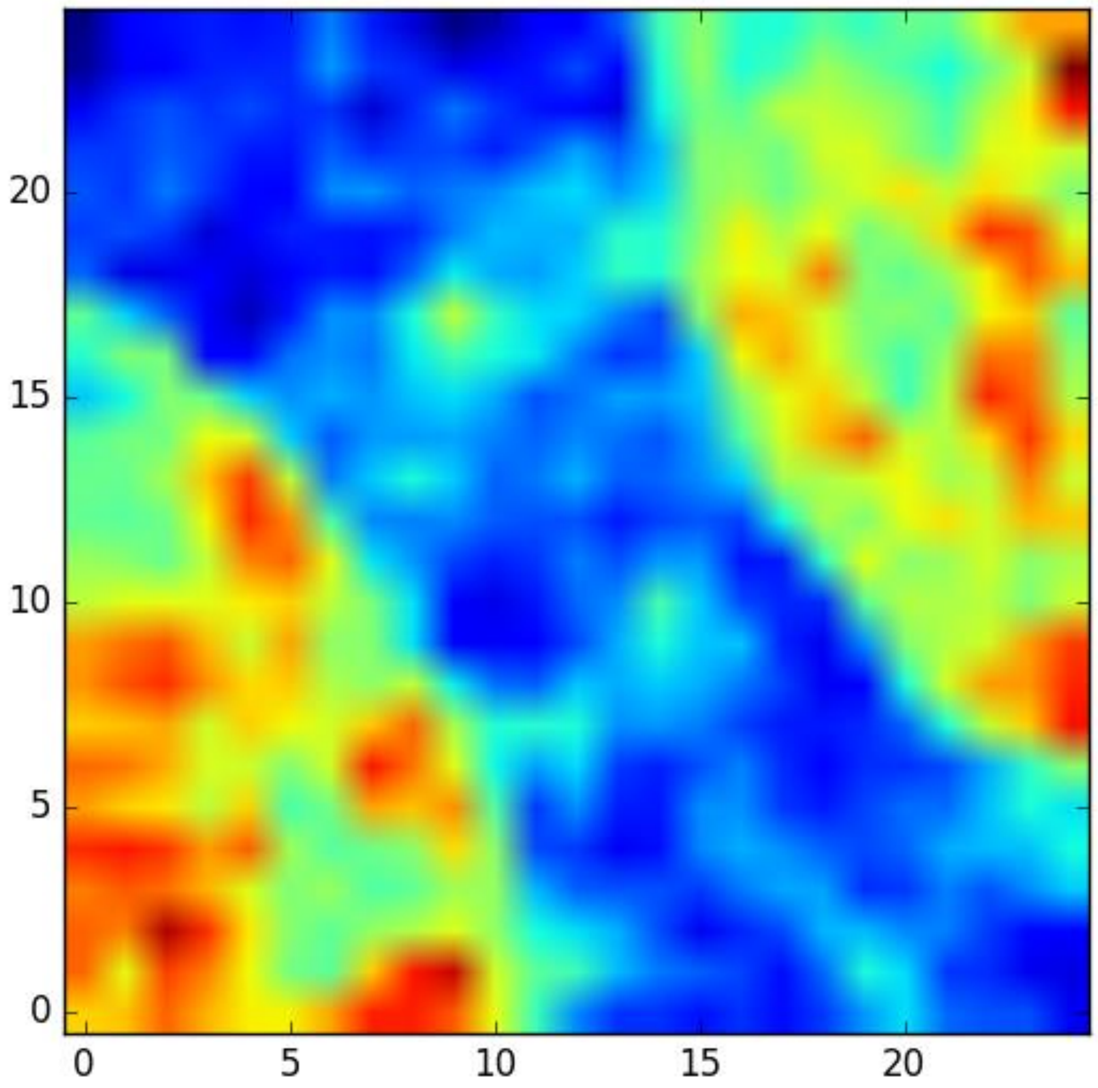


→ DiLepton rest frame

Results



DiLepton
rest frame



Last progress of SOM: U-Matrix that show clear signal separation for “easy” channel