Group Meeting

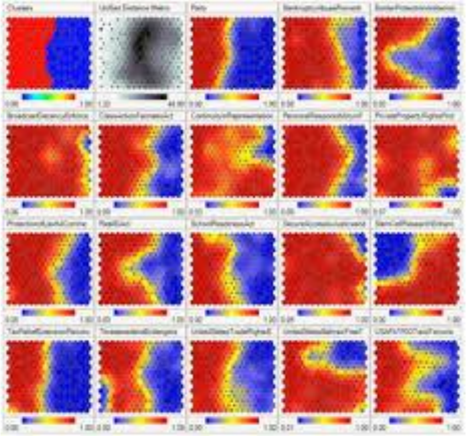
05/03/2019

(Analysis & Others)

Zulkaida Akbar

Outline

Self Organizing Map

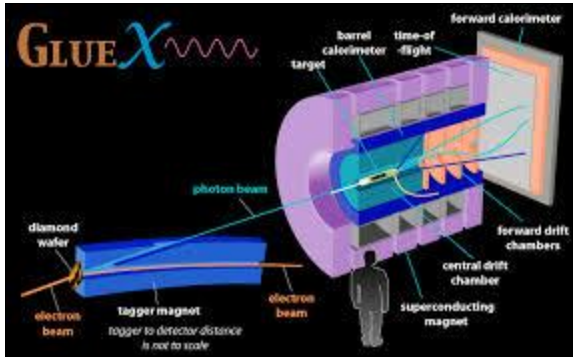


SpinQuest

Fermilab

CLAS

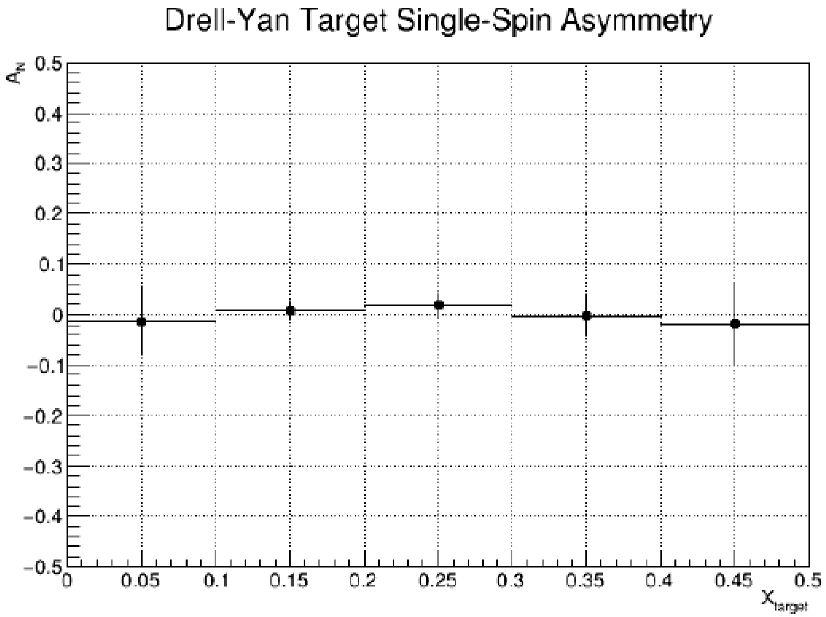
GlueX

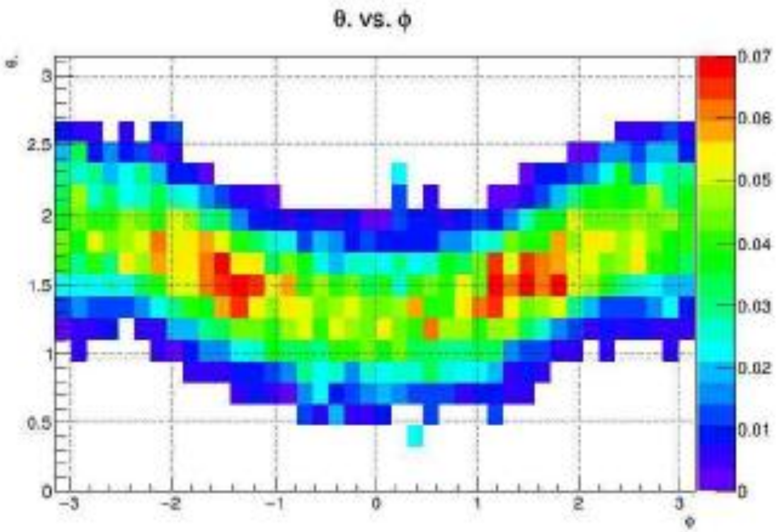


SpinQuest

Analysis Meeting:

- Key task identification
- Sivers-like asymmetry extraction (MC)
- Simulation setup
- Detector acceptance study
- Mock Data Challenge
- Tutorial





Relevant issue before production run

Issue	Description	PIC 1	PIC 2
Packing factor	Perform a packing factor measurement	Arthur	David?
Dilution Factor	Establish the best method to measure the dilution factor and its systematics Figure out the cross-sections, and do the simulation studies.	David	David?
Additional recoil proton detector	Simulate the feasibility to add recoil proton detector in a particular place for systematics study (and also all other detectors for future upgrade)	Josh	Zulkaida
Background studies	• Establish the best method to find the line shape & simulate the random background • Establish the best method to separate events from beam dump		
Detector	Establish methods to measure the	Mindy	

Relevant issue before production run

Issue	Description	PIC 1	PIC 2
Trigger Performance	Establish methods to measure the trigger efficiency	Umich group	
Sivers-Asymmetry Framework	Setup a framework/macro to extract Sivers Asymmetry from a Full simulation Monte Carlo Figure out the best kinematics to present the sivers asymmetry (Xb, qT, pT, dimuon mass)	Zulkaida Dustin	Forhad
E906-E1039 Bridge	Provide information or general framework or dictionary for new comers to learn E906 data	Kenichi	
Overall systematics study	Keeping track for all non-negligible systematic source that affect the Sivers-symmetry	Arthur	
Tracking	Establish an efficient tracking algorithm & k-Tracker optimization		

Relevant issue before production run

Issue	Description	PIC 1	PIC 2
Boer-Mulder study for E906 data	use part of the E906 data that haven't been analyzed to study Boer-Mulder function		
Cosmic Ray Studies	Analysis associated with the Cosmic Ray commissioning		
Sivers review	Review/summary study of all previous Sivers measurements and theoretical model/prediction		
E1039 MC generator	Improving the MC generator for E1039		

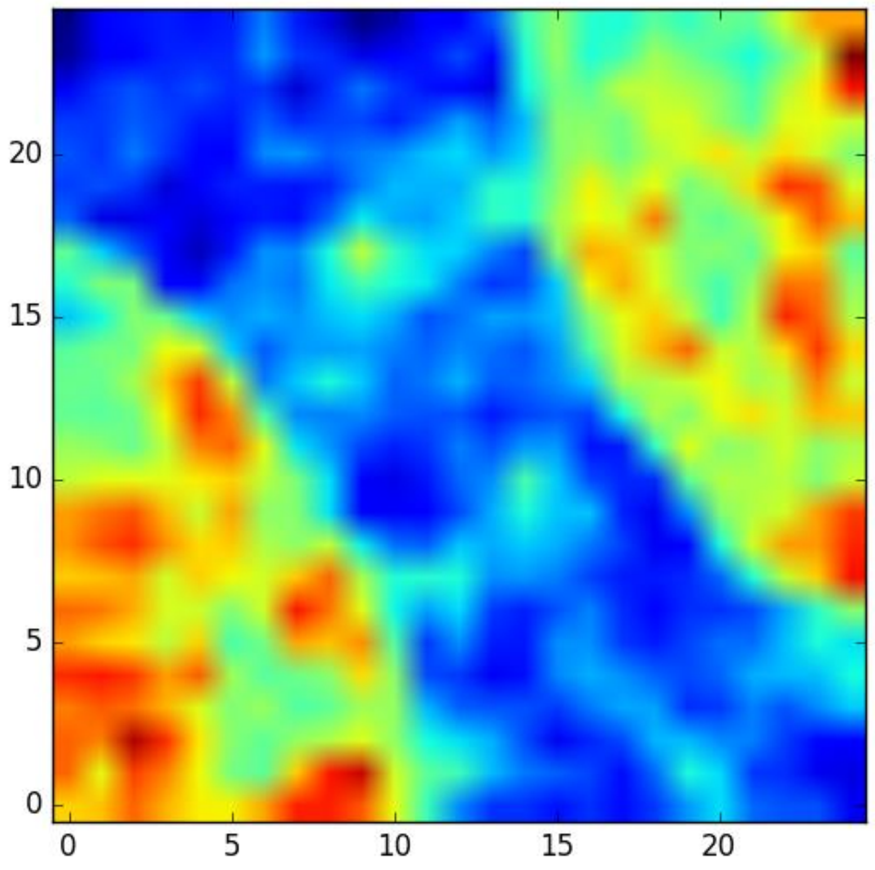
- The machinery is set up at polar machine
- The machinery is set up at Jlab
- Scripts are available for 2pion/2kaon/1p-1k
  Final states analysis
- MC exercise

CLAS

Self Organizing Map

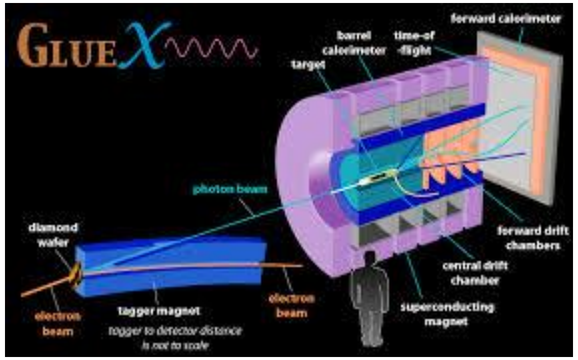
- Just started documenting: https://wiki.shanti.virginia.edu/display/twist/Self+Organizing+Map

- We learned that SOM effectively separates Signal/Background for easy channel
- The S/B separation using SOM works for both supervised and unsupervised learning



Umatrix representation

GlueX

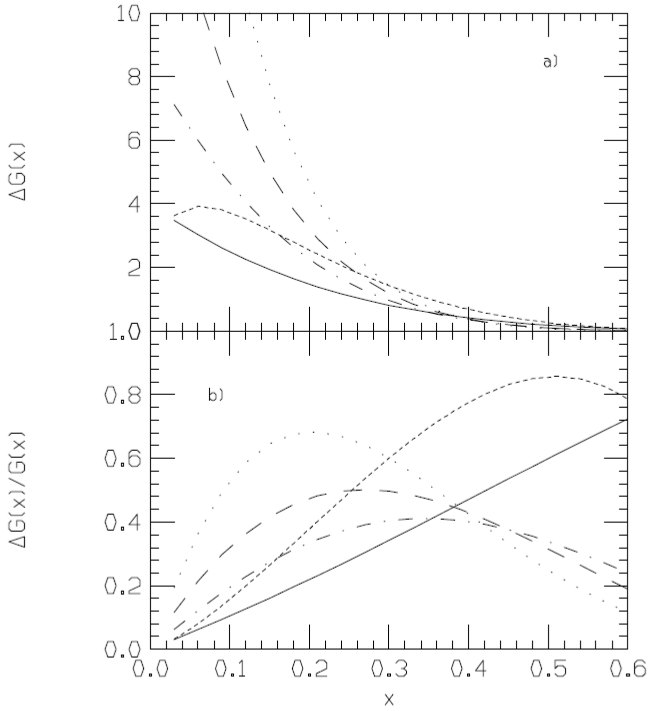


GLUEX
forward calorimeter
barrel calorimeter
time-of -flight
target
photon beam
diamond wafer
forward drift chambers
central drift chamber
superconducting magnet
electron beam
tagger magnet
tagger to detector distance is not to scale
electron beam

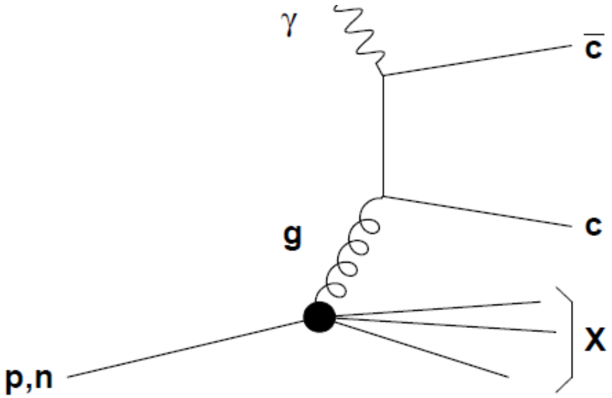
Physics

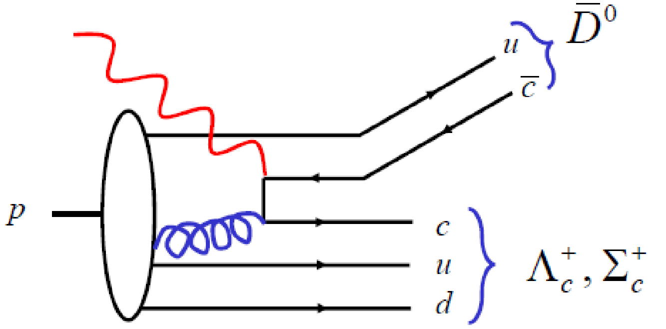
Probing Gluon Polarization:

Through g1 measurement (Model dependent)



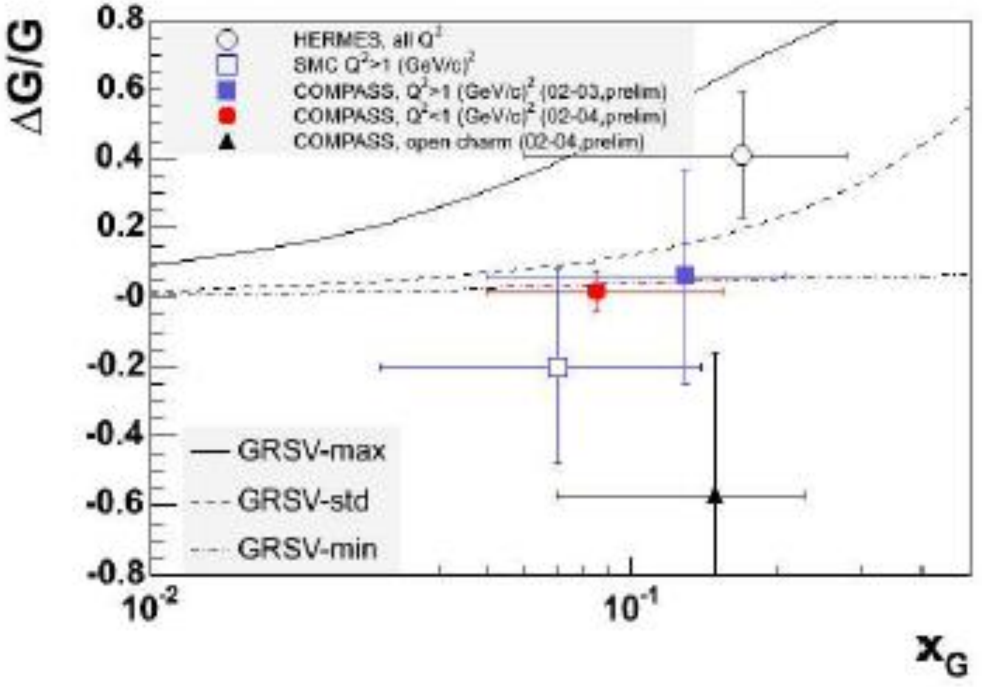
Open charm production (photon-gluon fusion)





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

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

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

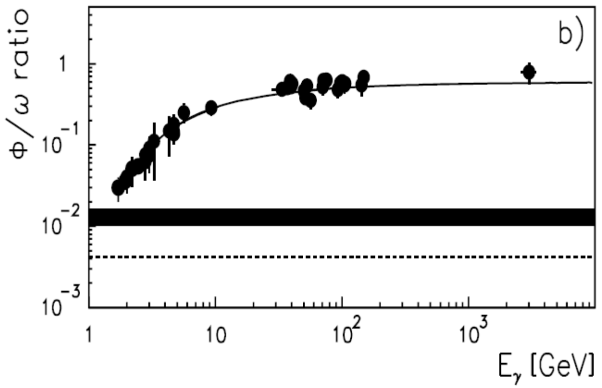
$$N_{detect} = N_\gamma \sigma_{tot} \left(\frac{l \rho t N_A}{A} \right) (B.F.) \varepsilon \kappa$$

- 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 $\gamma\, p \to \Lambda_c^+\, \bar{D}^0$
- .31 events/hr/nb $\gamma\, p \to \Sigma_c^+\, \bar{D}^0$
- .86 events/hr/nb $\gamma\, p \to \Sigma_c^{++}\, D^-$

- Exclusive
- No K/Pi separation

Physics

- OZI rule is strongly violated especially in Photoproduction



Ratio from the photoproduction

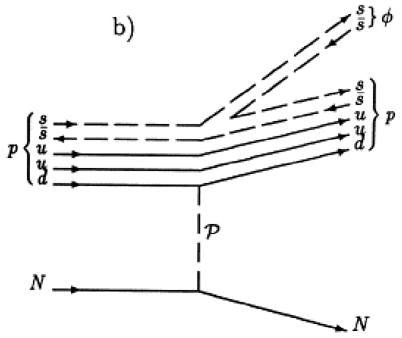
Ratio from the hadroproduction

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

T. J. Hobbs[1*] and Mary Alberg[1,2], Gerald A. Miller[1]

[1]*Department of Physics, University of Washington, Seattle, Washington 98195, USA*

[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]

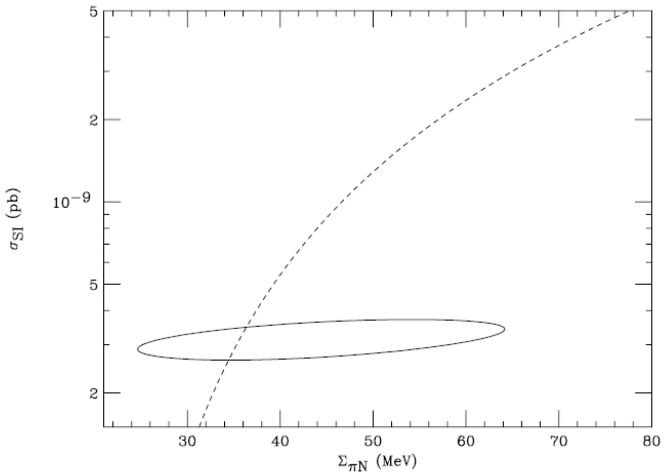
Strange Quark Contributions to Parity-Violating Asymmetries in the Forward G0 Electron-Proton Scattering Experiment

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]

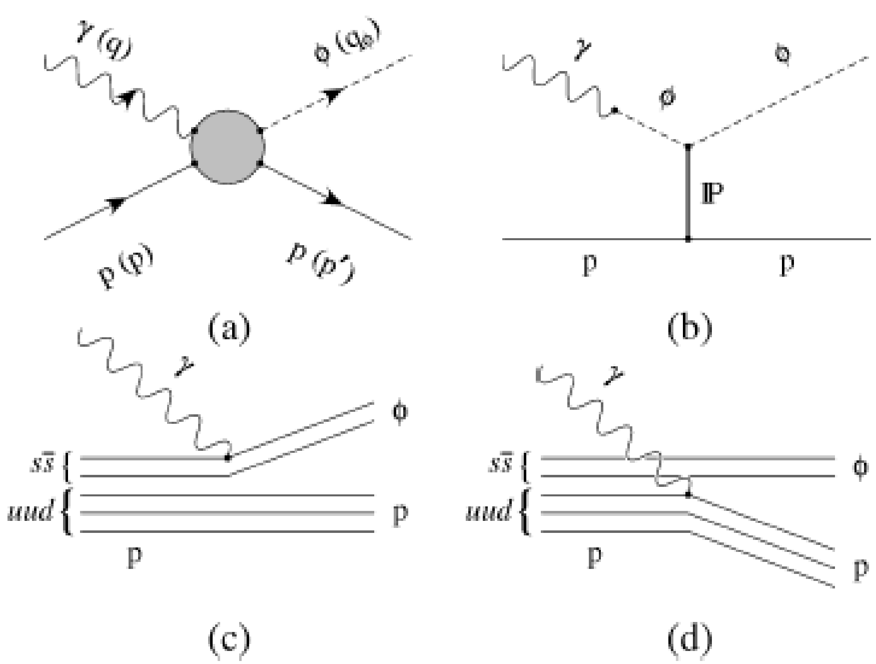
- An accurate determination of the strange quark sigma term is of principle importance in the reduction of hadronic uncertainties in the predicted dark matter cross sections for a wide range of models.

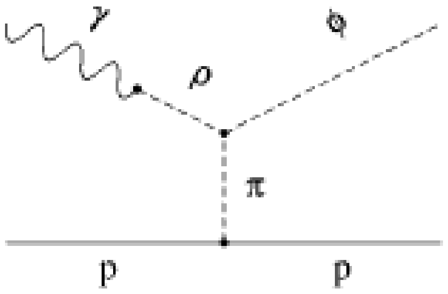


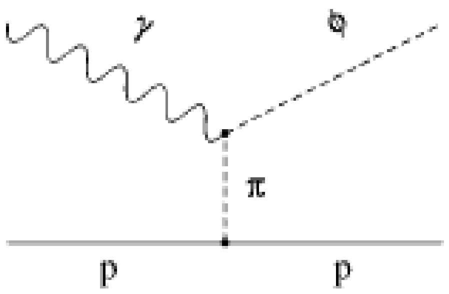
Strange quark content of the nucleon and dark matter searches

R. D. Young*
Special Research Centre for the Subatomic Structure of Matter (CSSM) and ARC Centre of Excellence in Particle Physics at the Terascale (CoEPP), School of Chemistry and Physics, University of Adelaide, SA 5005, Australia.

Theory







Theory

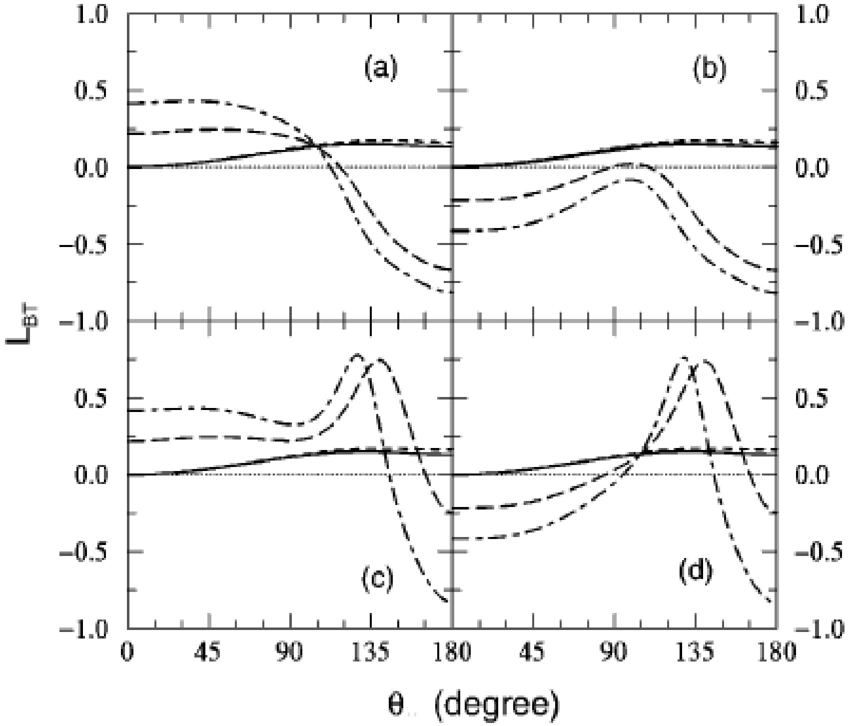


FIG. 4. The longitudinal asymmetry $\mathcal{L}_{\rm BT}(\theta)$ at $W = 2.155$ GeV with $B^2 = 0\%$, i.e., the VDM and OPE (solid lines), 0.25% (dashed lines), and 1% (dot-dashed lines) assuming that $|a_0| = |a_1| = 1/\sqrt{2}$. The dotted line, which nearly overlaps the solid line, is the prediction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

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

Previous Measurement

No Previous measurement available

Channel & PID & RATE

$$\gamma p \rightarrow p\varphi \rightarrow pKK$$

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

Additional

- 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

M. Shi,[1,2,*] I.V. Danilkin,[2] C. Fernández-Ramírez,[2] V. Mathieu,[3,4]
M. R. Pennington,[2] D. Schott,[5] and A. P. Szczepaniak[2,3,4]
(Joint Physics Analysis Center)

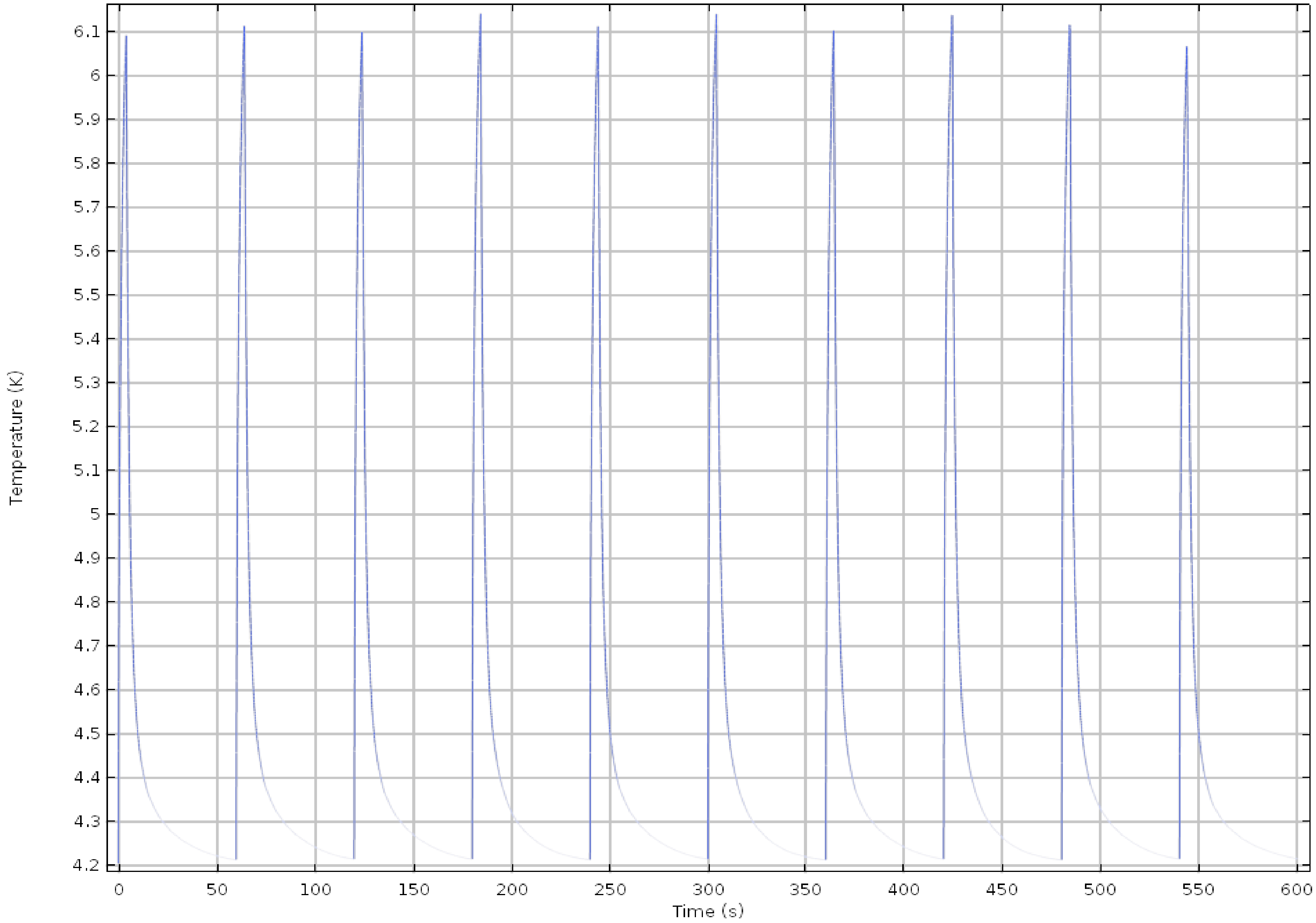
[1]*Department of Physics, Peking University, Beijing 100871, China*
[2]*Theory Center, Thomas Jefferson National Accelerator Facility, Newport News, VA 23606*
[3]*Center for Exploration of Energy and Matter, Indiana University, Bloomington, IN 47403*
[4]*Physics Department, Indiana University, Bloomington, 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.

Magnet Simulation

Results

The maximum temperature of the coil as a function of time



Maximum Temperature profile Tmax(t) for E1039:

- 120 GeV proton
- 1e12 proton/s
- NH3 Target

Conclusion: It is save to run at 1e12 proton/s but I recommend this intensity to be considered as the upper limit

What Next?

Before Commissioning run

- Fix the numerical convergence issue
- Overleaf documentation (collaborative LaTex editor)
- Fine tuning geometry
- Systematic study
- Install 8 temperature sensor (Carlos)
- Create Temperature prediction for those sensors as a function of beam intensity

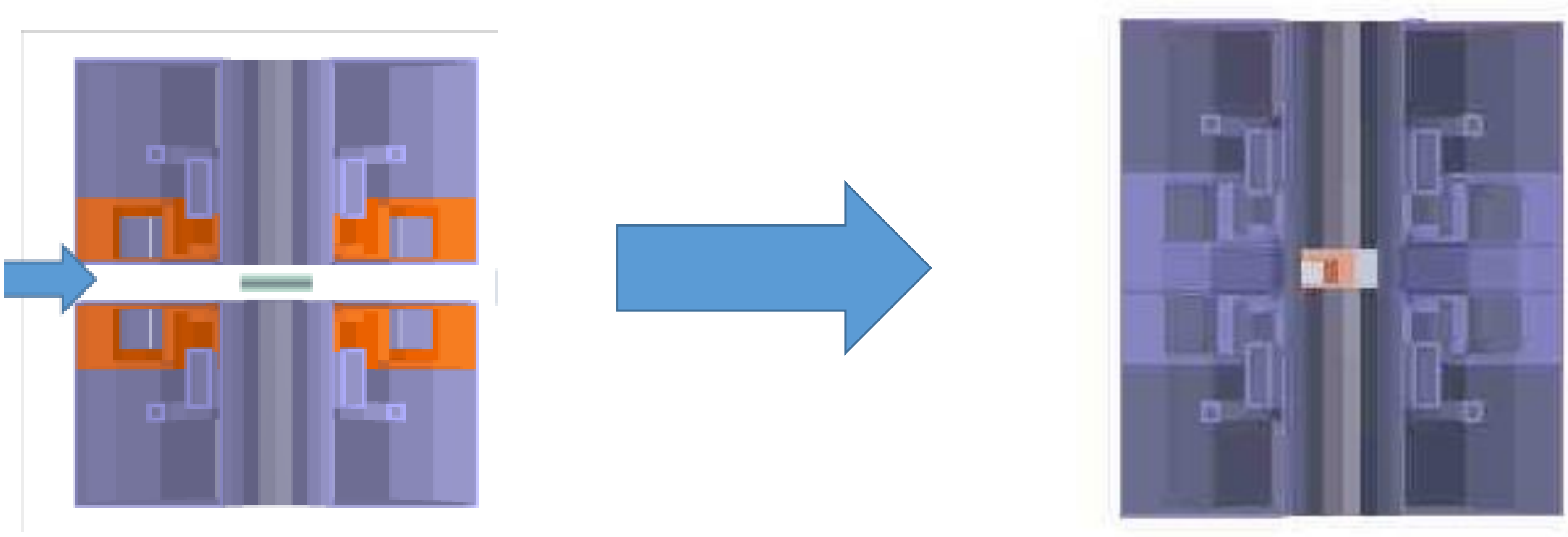
During Commissioning run

- Compare the simulation prediction vs experiment

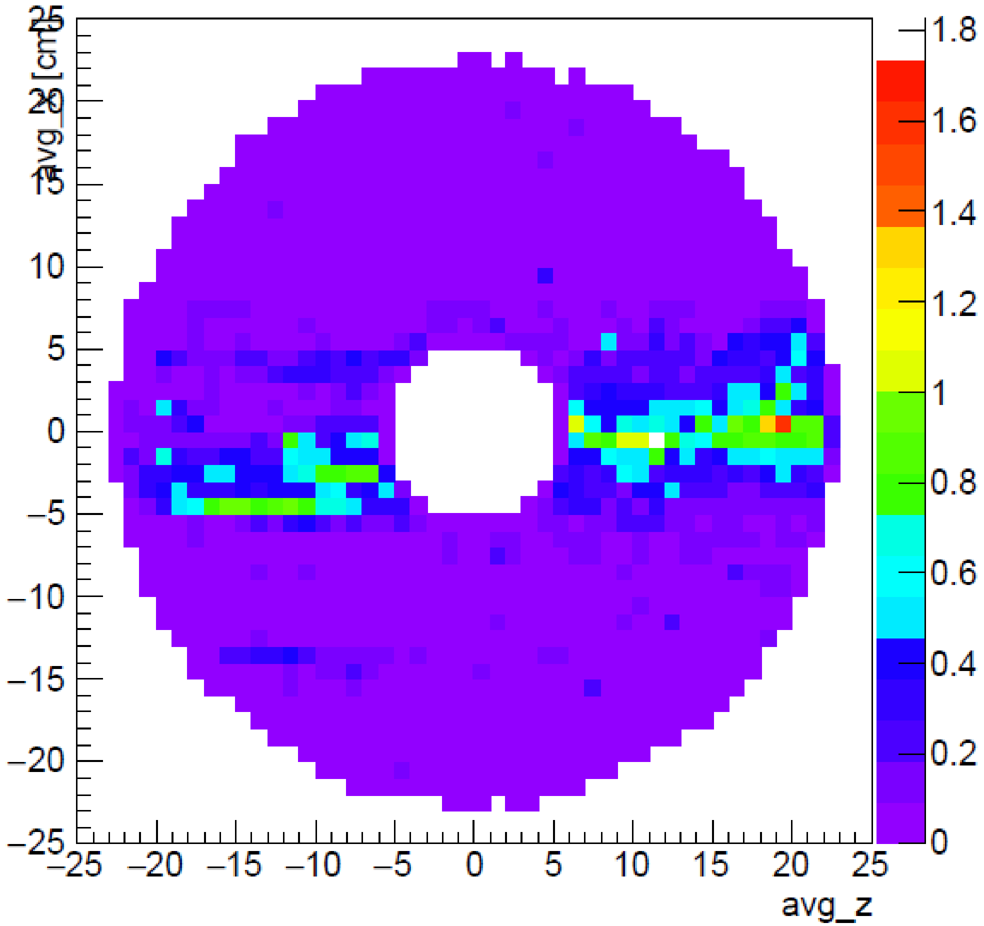
After Commissioning run

- Publication??

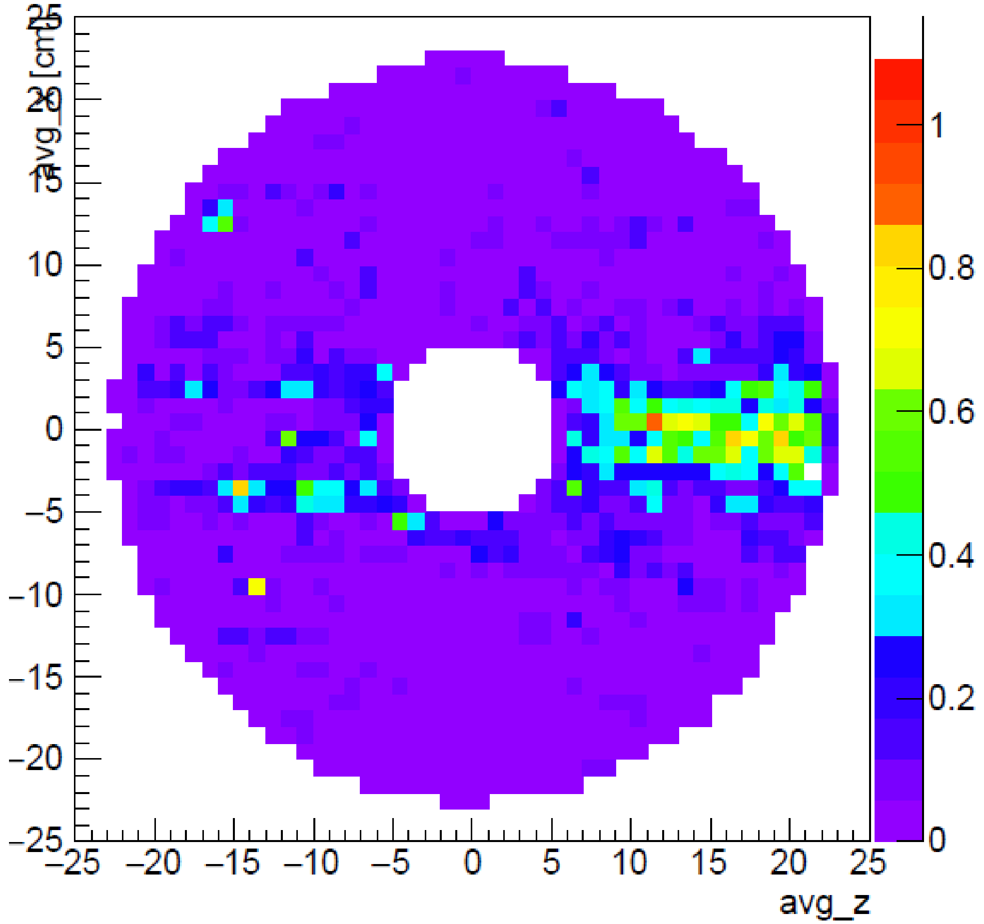
Improving geometry in Geant



Beam Position Study



Beam position: center



Beam position: drift by 0.5 cm

MicroQuench Study

- The beam intensity “jump” in the order of ns
- This “jump” is not good for the magnet
- Unfortunately, we could not run COMSOL with time step in the order of ns
- Plan: Semi-Analytical study with perturbation theory