CLAS Deep Processes Working Group Summary

4 November16
CLAS Collaboration Meeting
Jefferson Lab
Keith Griffioen

Papers accepted/published since June 2016

CLAS Paper	Title	Lead Author	Journal
2016-01	Target and Beam-Target Spin Asymmetries in exclusive π^+ and π^- electroproduction with 1.6 to 5.7 GeV	P.Bosted	Phys Rev C 94, 055201
2016-05	Measurement of Target and Double-spin Asymmetries for $ep \to e\pi^+ n$ Reaction in the Nucleon Resonance Region at Low Q^2	X. Zheng	Phys Rev C 94, 045206

Papers submitted

CLAS Paper	Title	Lead Author	Journal
2015-07	Target and double spin asymmetries of virtual π^0 production with a longitudinally polarized proton target and CLAS	A. Kim	Phys Rev Lett
2016-02	Measurement of two-photon exchange effect by comparing elastic $e^{\pm}p$ cross sections	D. Rimal	Phys Rev C
2016-07	Target and Beam-Target Spin Asymmetries in exclusive π^+ electroproduction for $Q^2>1$ GeV^2 from the eg1-dvcs Experiment	P.E. Bosted	Phys Rev C
2016-08	Exclusive η electroproduction at W>2 with CLAS and transversity GPDs	I. Bedlinskiy	Phys Rev C
2016-06	Differential Cross Sections and Polarization Observables from CLAS K* Photoproduction and the Search for New N* States	A.V. Anisovich	Phys Lett B
2016-04	Beam-Target Double Spin Asymmetry In Quasi-Elastic Electron Scattering Off the Deuteron with CLAS	M. Mayer	Phys Rev C

First stage of ad hoc review complete

CLAS Paper	Title	Lead Author	Status	Journal
2016-09	Target and Beam-Target Spin Asymmetries in Exclusive π^0 Electroproduction for $Q^2>1$ GeV^2	Bosted	Author check	Phys Rev C

With ad hoc Committee

Title	Lead Author	Run group
Beam spin asymmetries of ep->epη in the deep inelastic regime	A. Kim	e1f
Determination of the Proton Spin Structure Functions for $0.05 < Q^2 < 5.0$ GeV^2 using CLAS	R.G. Fersch	eg1
Photon Beam Asymmetry Sigma for eta and eta’ photoproduction from the proton	P. Collins	g8b
Measurements of ep->e’pi+pi-p Cross Sections with CLAS at 1.40 GeV < W < 2.0 GeV and 2.0 GeV2 < Q2 < 5.0 GeV2	E.L. Isupov	e1-6
Measurements of the Differential and Total Cross Sections of gd->K0 Lambda (p) Reaction within the resonance region	N.Compton	g13, g10

Author	Run Group	Title	WGC	ad hoc	Pub
P Bosted *et al.*	e1-6	Beam Asymmetries in Exclusive pi+ electro production for W>1.7 GeV from e16	Begin: 160720 P. Stoler M. Ungaro S. Procureur		
N Harrison, K Joo *et al.*	e1f	Exploring the Structure of the Proton via Semi-inclusive Pion Electroproduction	Begin: 160511 H Avakian M Osipenko A Movsisyan End:		
N Saylor *et al.*	e1-dvcs2	e1-dvcs analysis note	Begin: 150216 K Joo A Kim C Smith		
I Albyrak *et al.*	g12	Time-Like Compton Scattering	Begin: 150325 S Niccolai R Paremuzyan M Paolone link		
A Fradi *et al.*	e1-dvcs	Deeply Virtual Production of the ρ^+ Meson on the Proton	Begin: 150316 S Pisano K Giovanetti V Kubarovsky link		
S Koirala S Kuhn *et al.*	eg1-dvcs	Measurement of Single and Double Spin Asymmetries in Semi-Inclusive Deep Inelastic Scattering on Proton and Deuteron	Begin:140929 M Mirazita P Bosted M Contalbrigo link End:151001		

Thursday, 3 November 2016

08:00 - 12:10

Deep Processes

Convener: Keith Griffioen (College of William & Mary)

Location: CEBAF Center (A110)

08:50 **Deep Processes Working Group Business** *10'*

Speaker: Keith Griffioen

09:00 **Update on Run Group C** *20'*

Speaker: Sebastian Kuhn (ODU)

Material: Slides

09:20 **Update on Run Group F** *20'*

Speaker: Gabriel Charles (Old Dominion University)

Material: Slides

09:40 **Update on EG4 Analysis** *20'*

Speaker: Krishna Adhikari (Mississippi State University)

Material: Slides

10:00 **Status of DVCS measurement from e16 data** *20'*

Speaker: Aram Movsisyan (INFN-Ferrara)

Material: Slides

10:20 **Energy dependence of azimuthal asymmetries** *20'*

Speaker: Harut Avagyan (Jefferson Lab)

Material: Slides

RG C TO DO: Kuhn: Run Group C (Polarized NH3 Target)

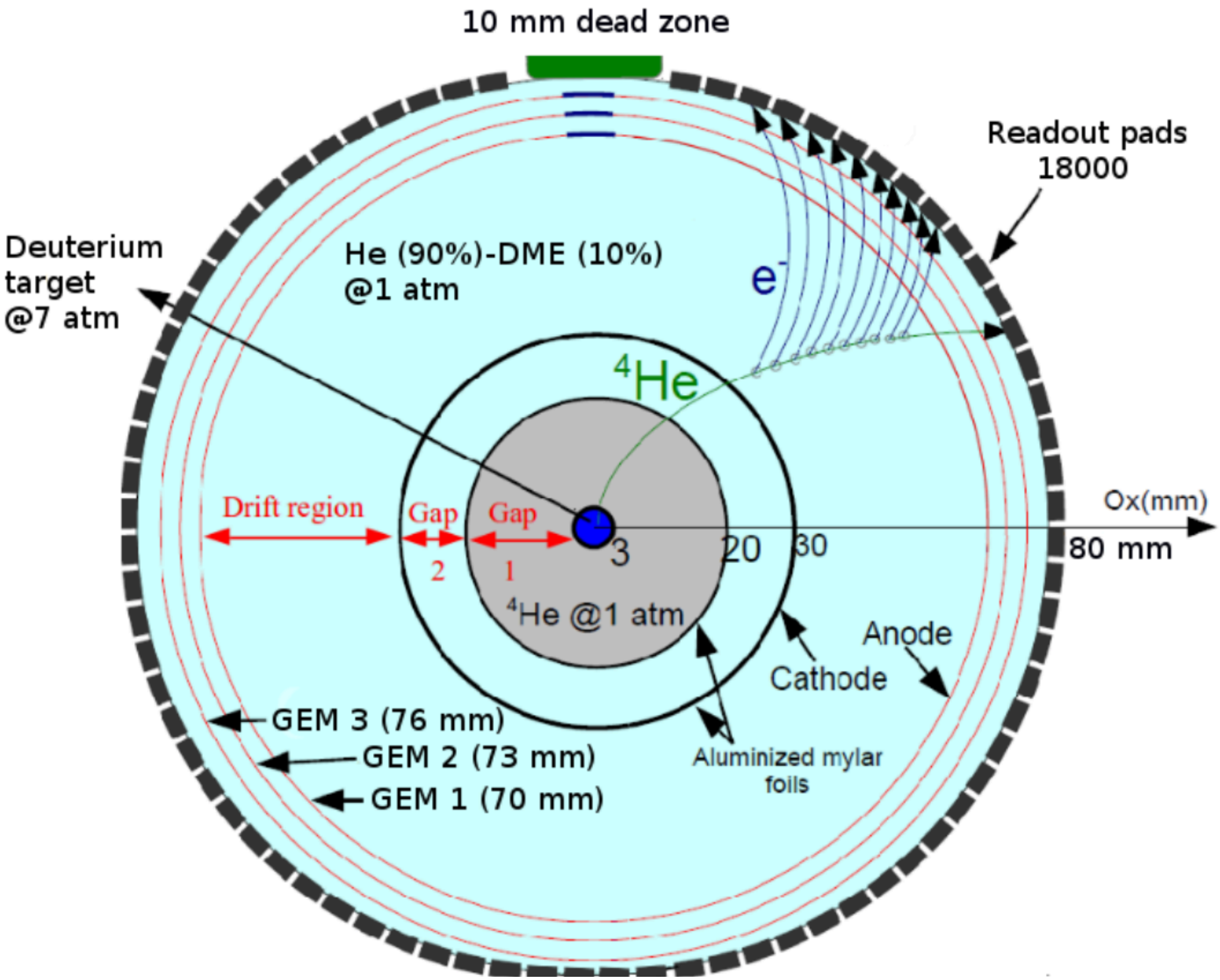
1. Target material: irradiation (new UITF?; cold/ultracold? Moving around and/or rastering? Cells, isotope analysis, weighing, dilution factor, microstructure? (UTFSM->heat flow optimization)
2. Raster system (speed, shape, amplitude/range, position of magnets, driver, readout/calibration; induced SL? Noise? "Sheet of Flame"?) -> ? Also check with HD-Ice
3. Møller polarimeter system (readiness; optimize running, accuracy) -> RG A
4. rest of beam line (BPMs, harps, lumi (SLM?), steering) -> Stepan Stepanyan, FX, ?
    1. Yuri Sharabian: New TRD made of 0.6 μm Carbon sheet, can measure intensity, position, and energy!?!
5. Møller shield (with and without FT; optimize for rastering) Full background simulation ->Maurizio + Stepan, Volker and Josh Tan; Angela? Tony? Raffaella? Silvia?
    1. 2 different set-ups? Double cell, larger diameter with full Møller shield vs. single long cell, smaller diameter raster with FTon (less current, too)
6. Downstream: FC acceptance? (Solenoid focus) -> RG A
7. Solenoid field map: Initial measurements upon delivery; permanent Hall probes on strategic surfaces? Btot(z) at 10^-4 (NMR?SQUID?) on axis; complete spatial field map after KPP (remove CT).
8. full implementation of polarized target into GEMC, geometry and Common Tools
9. Full simulation of rates, acceptances, resolution, z-separation (-> dilution), backgrounds, systematic errors (e.g., beam-helicity tracking efficiency due to DSA in Møller scattering): Silvia N, Silvia P, Raffaella, Angela, Dariah S.; T. Forest)
10. We need Common Tool Experts to develop analysis procedures
11. Run plan (2.2 GeV? 6.6/8.8 GeV? In/outbending? Reduced/full Torus run? ancillary runs? beam current scan; no field run. optimized target operation – polarization reversal, anneal, exchange. Completely MT, MT with cells, grid of C foils,… permanent foil. Permanent or intermittent 14N, H?) - Silvia N., P. Bosted, S.K.
12. Geometry, integration, design drawings, readiness review, CALCOM
13. what do we need to do to measure DF precisely? How about Acc*eff*t(H)*Q?
14. Use BH (radiated elastic) to cover eff*acc*Pb*Pt over a wide kinematic range?
15. Pol. measurement with elastics (quasi-elastics) exclusive, BH.
16. SIDIS: Use multiplicities as function of z, pT, phi (doesn't require measuring cross sections NOR dilution factor; a LOT cancels out including RC effects on e- kinematics.) In principle, can use Baysian analysis with multipoles sin(n*phi), cos(n*phi) - run MC for each multipole (including const) separately, including RC, compare to measured moments.

Gabriel Charles, ODU BONuS

Larger angular coverage

OLD DOMINION UNIVERSITY IDEA FUSION

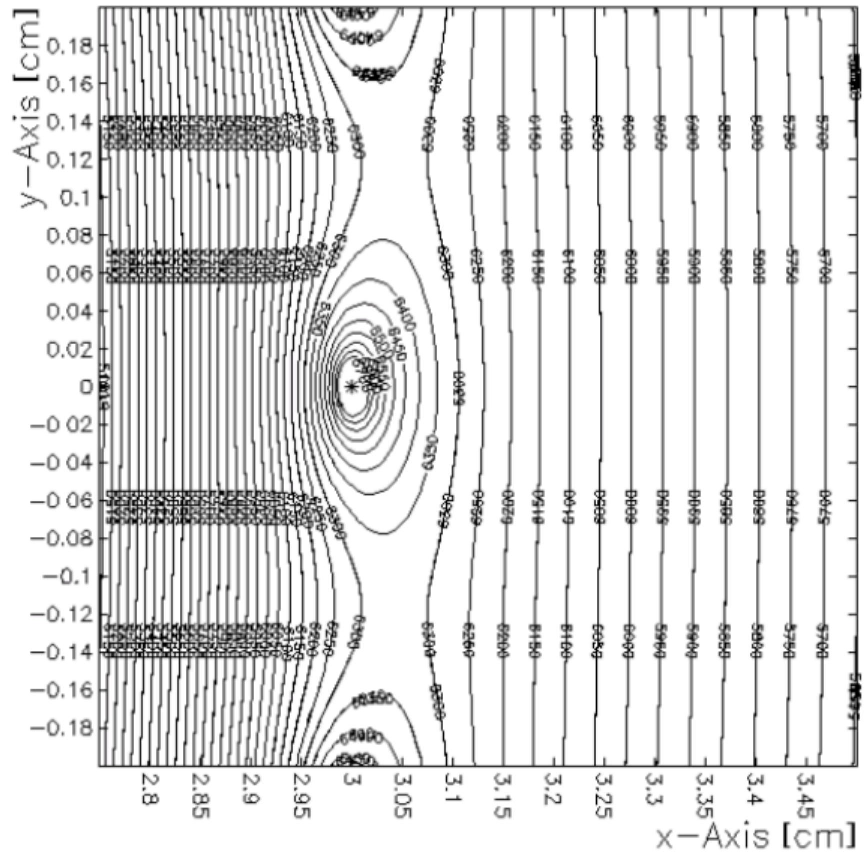
Different design, using different size GEM foils, and tape them at the top, larger radius, longer target and detector (400 mm long)



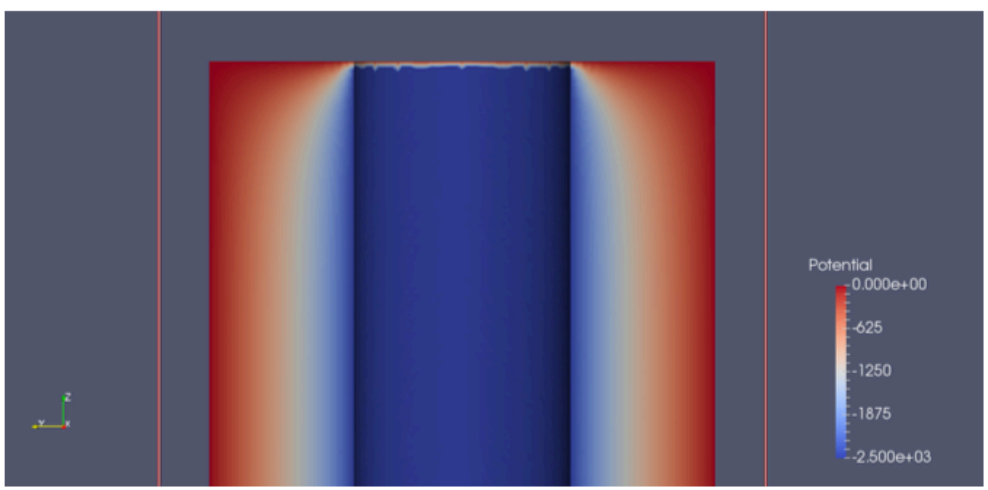
Replace the cathode foil by wires

Cathode foil could have unknown wrinkles

Studies on going to understand the effect on the drift time and Lorentz angle

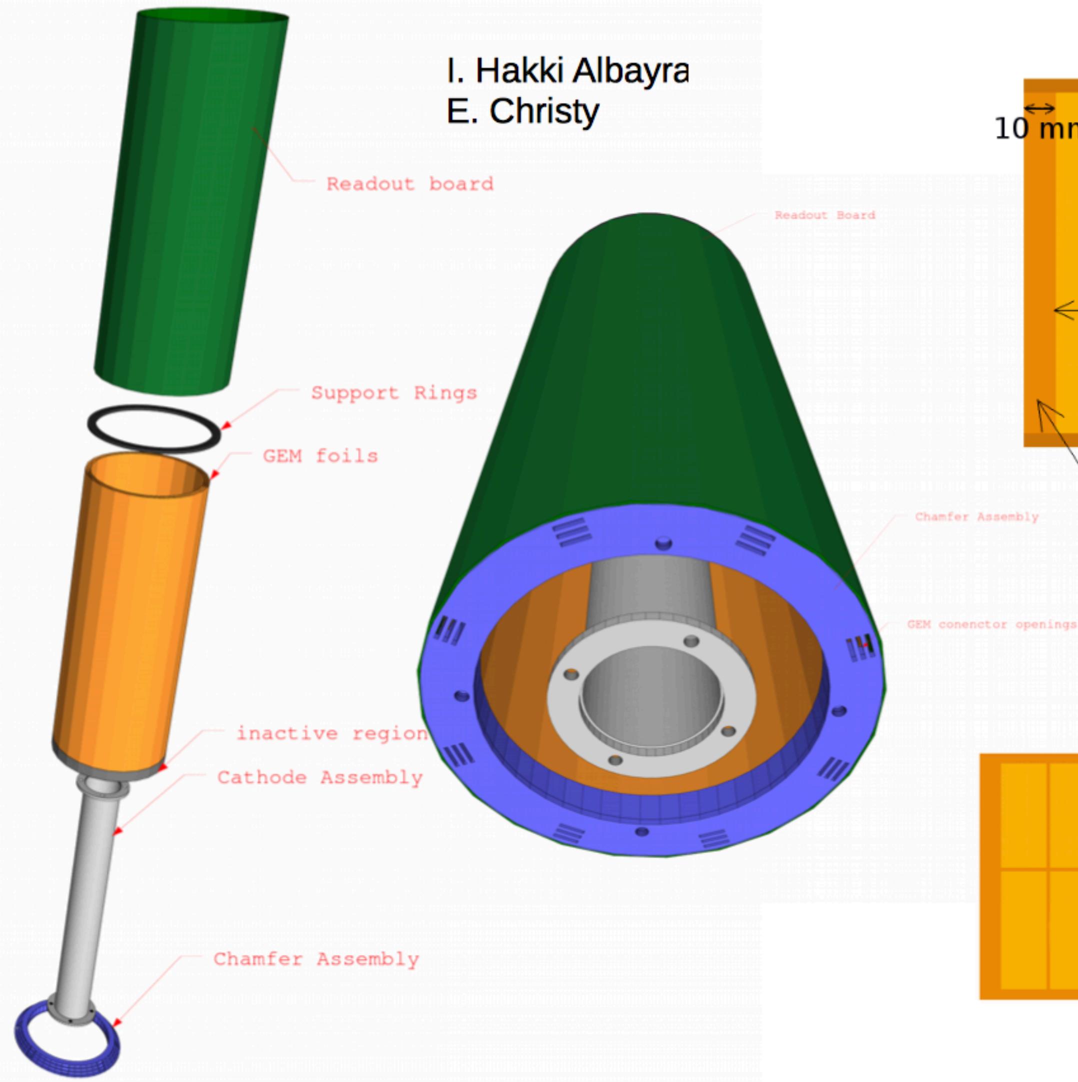


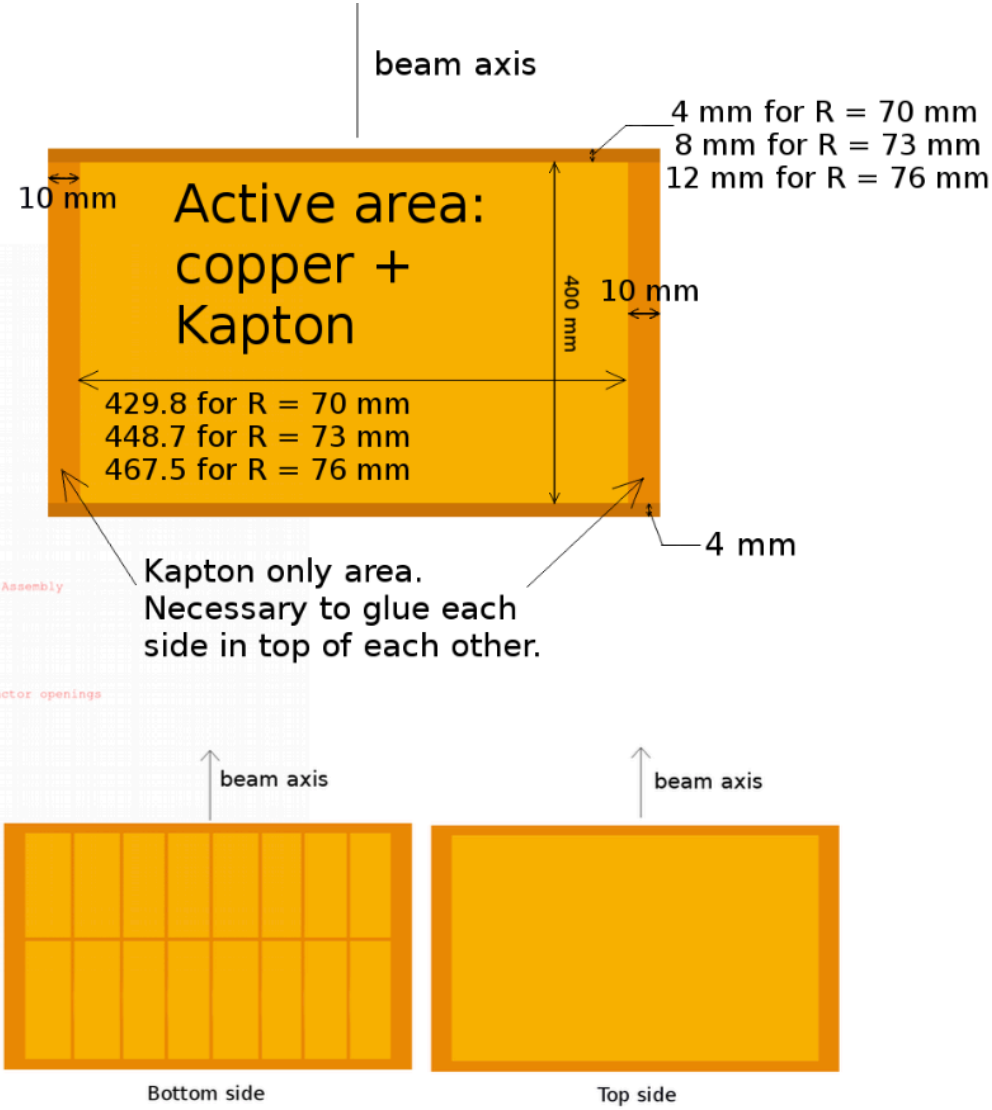
Cover end plates with a resistive paint to have a homogeneous electric field



Electric field is distorted at the edges if nothing is done

I. Hakki Albayra
E. Christy





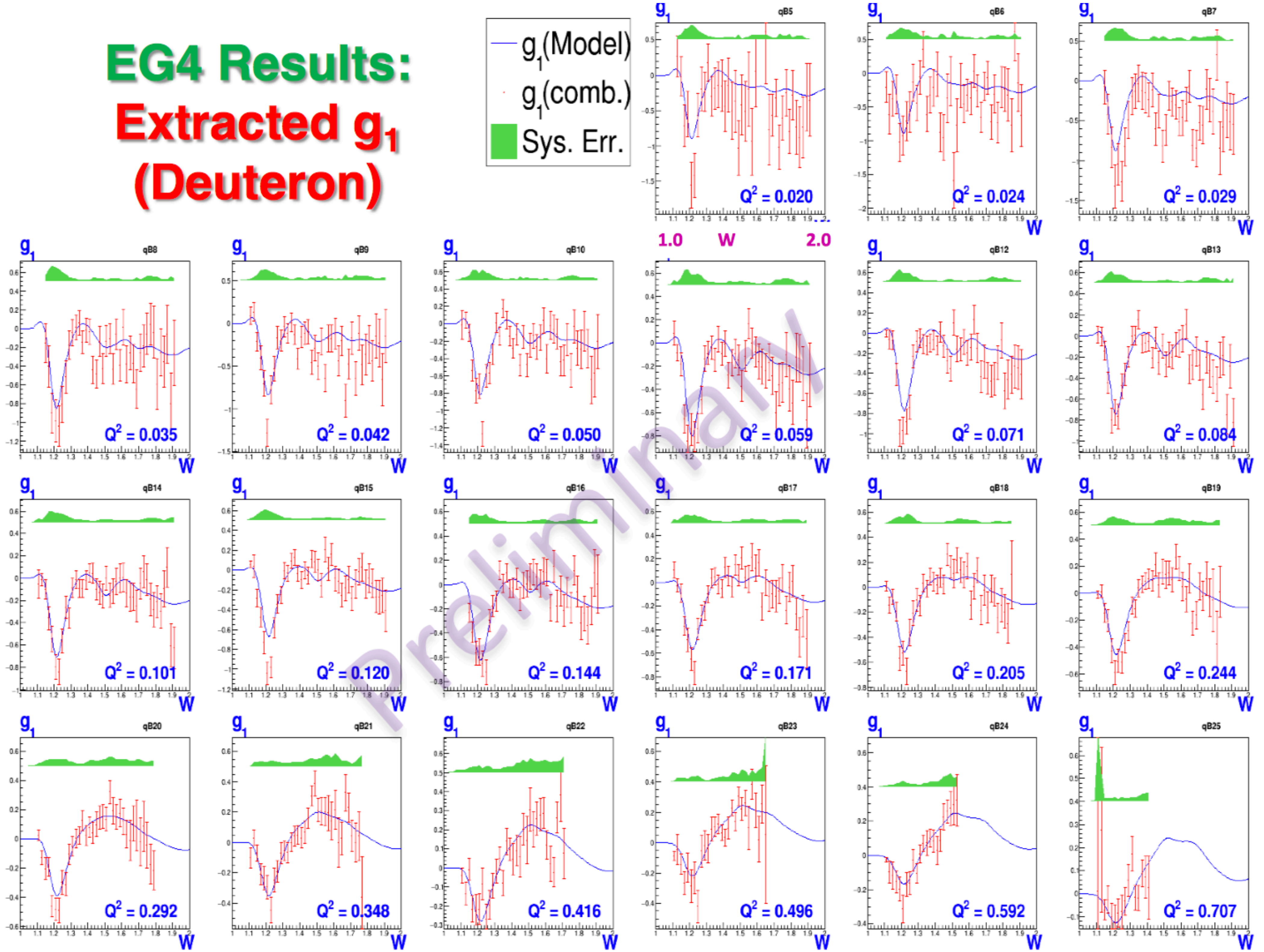
New Results on Deuteron Spin Structure function g_1 and its moments at low Q^2 from EG4 Experiment

Krishna P. Adhikari

Mississippi State University

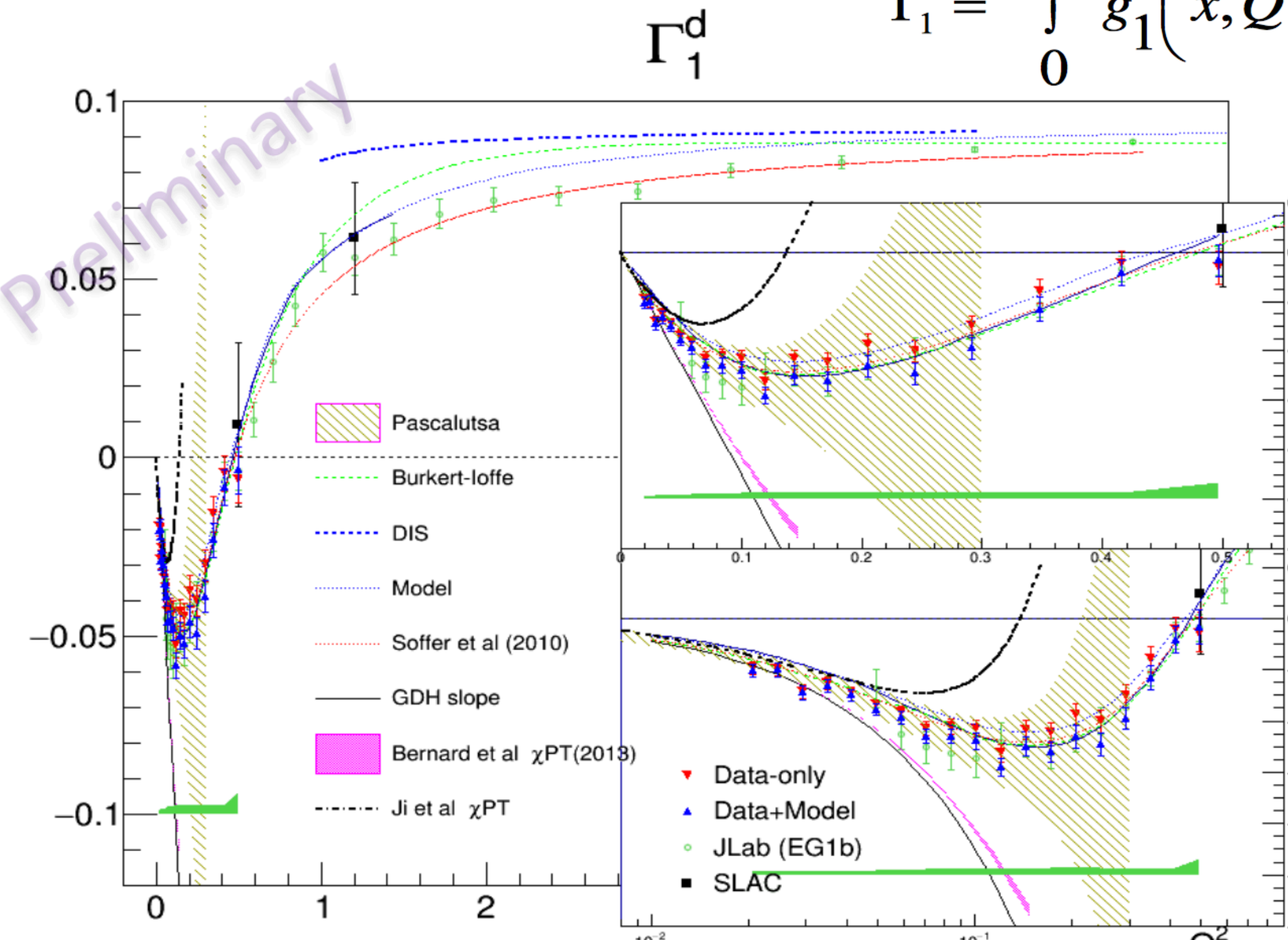
For the CLAS collaboration

EG4 Results:
Extracted g_1
(Deuteron)



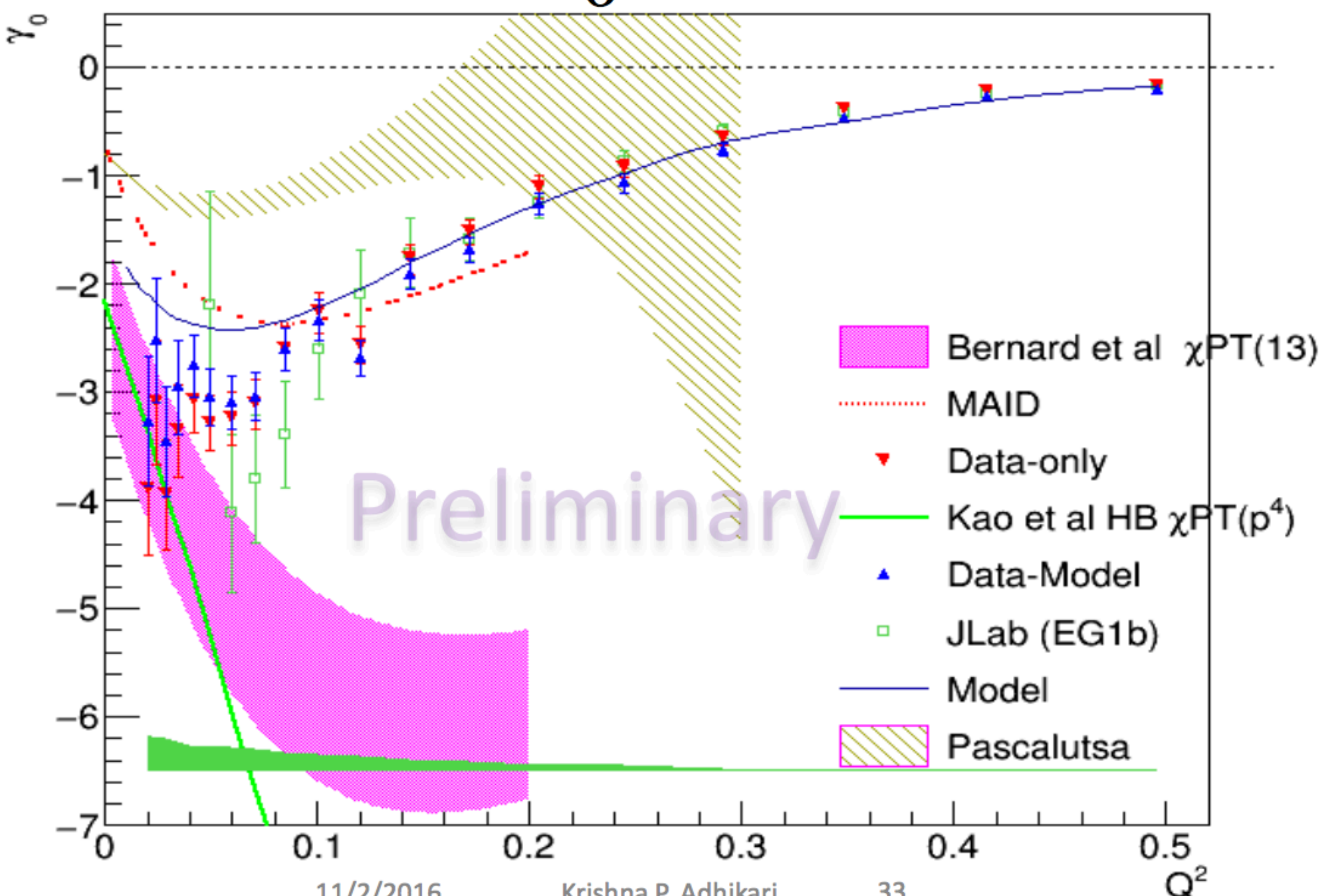
Results: First Moment

$$\overline{\Gamma}_1 = \int_0^{x_{th}} g_1\left(x, Q^2\right) dx$$



Results: Generalized Forward Spin polarizability (γ_0)

$$\gamma_0 = (16\alpha M^2/Q^6)\int_0^{x_{th}}\left(g_1 - \frac{2M^2x^2}{Q^2}g_2\right)x^2dx$$



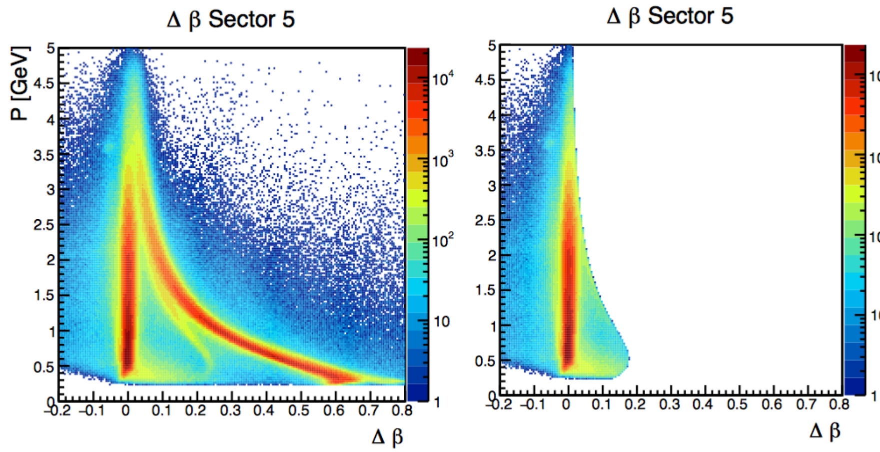
Status of DVCS Analysis from E1-6 Data

A. Movsisyan, H. Avakian, S. Pisano

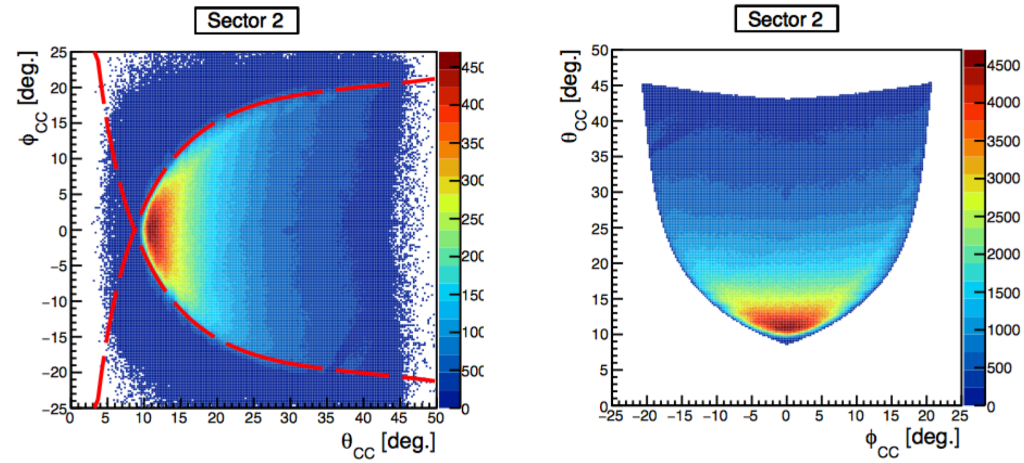
INFN-Ferrara

Event Selection (*ep* (*1γ*) (*2γ*) sample)

before the cut *after the cut*



before the cut *after the cut*



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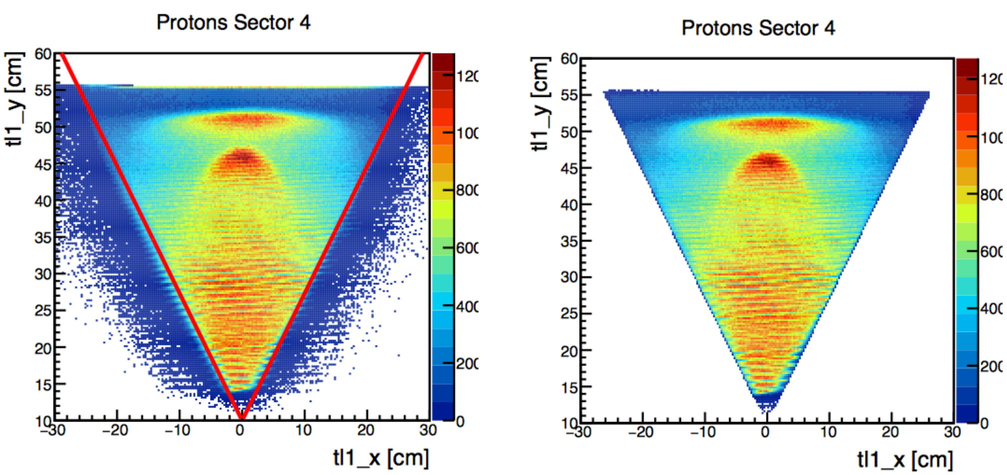
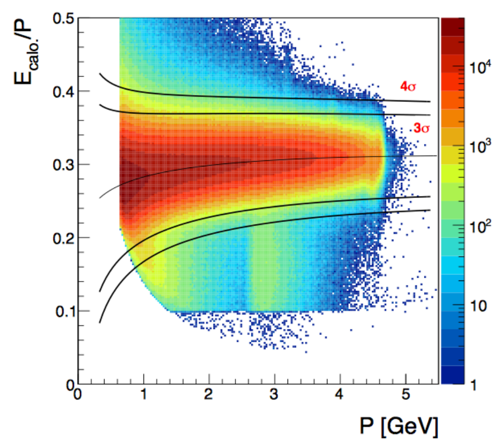
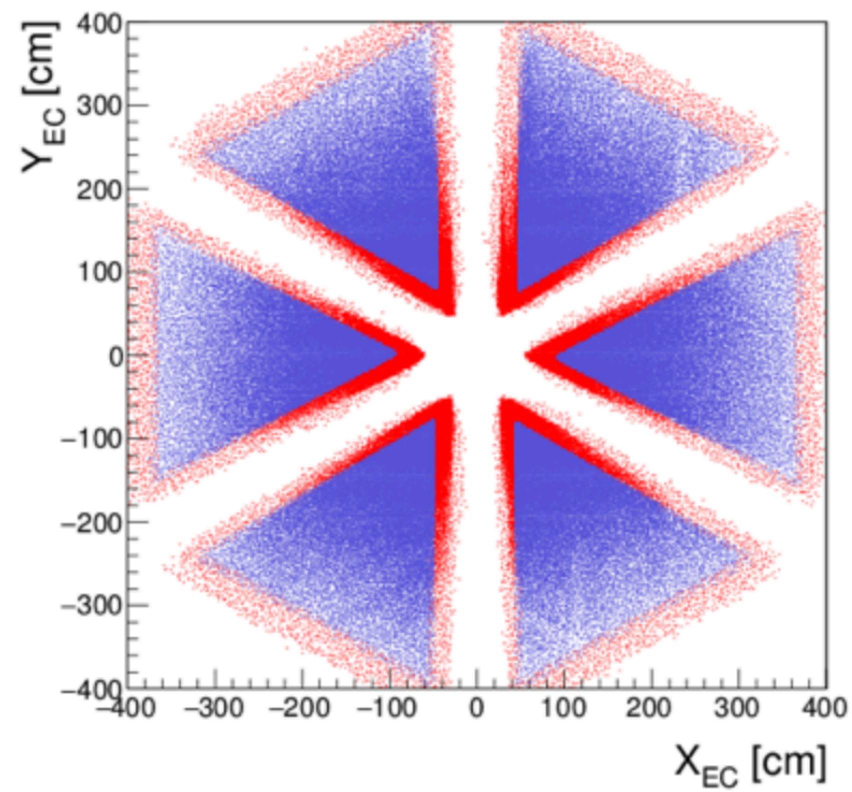
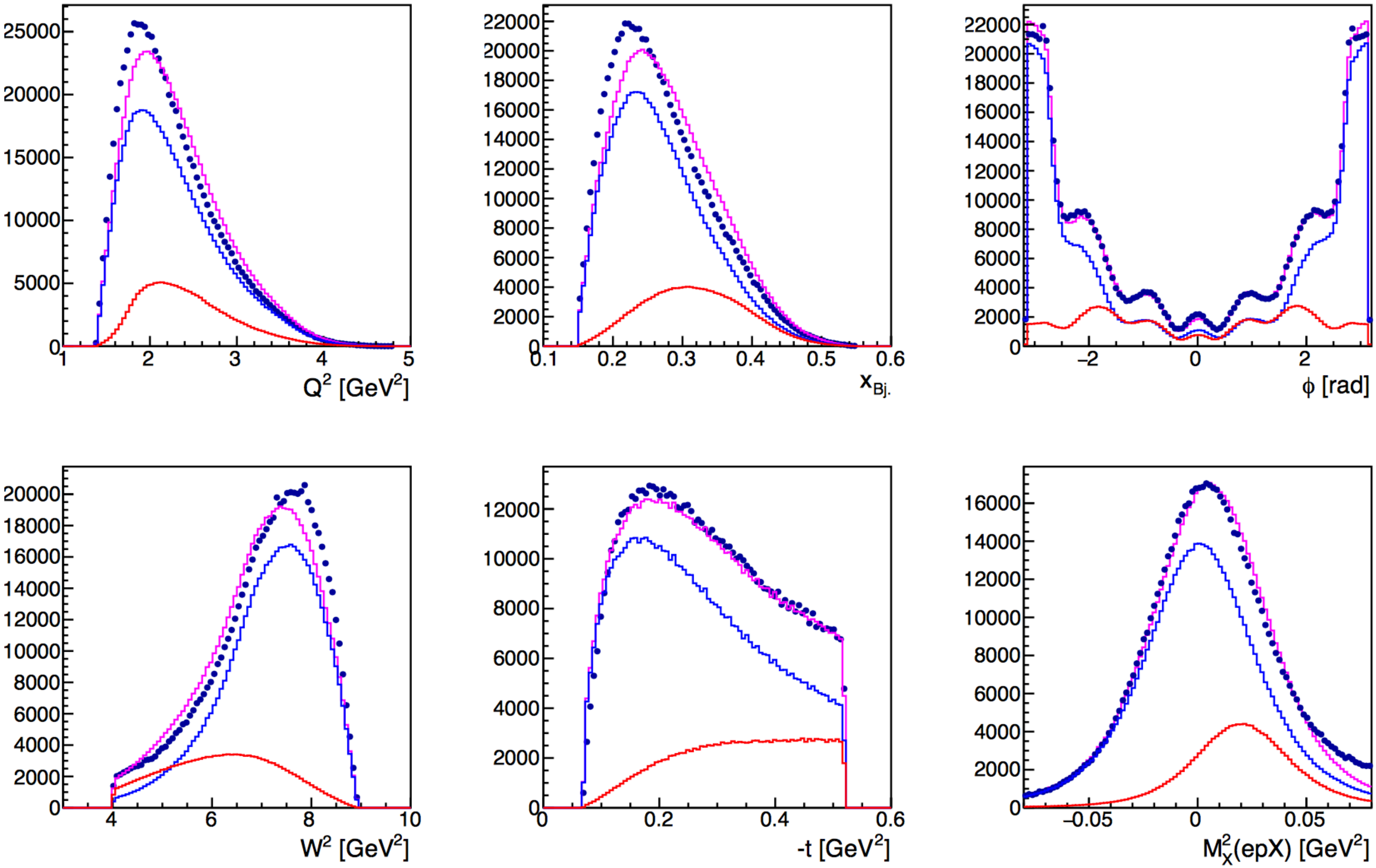
before the cut *after the cut*





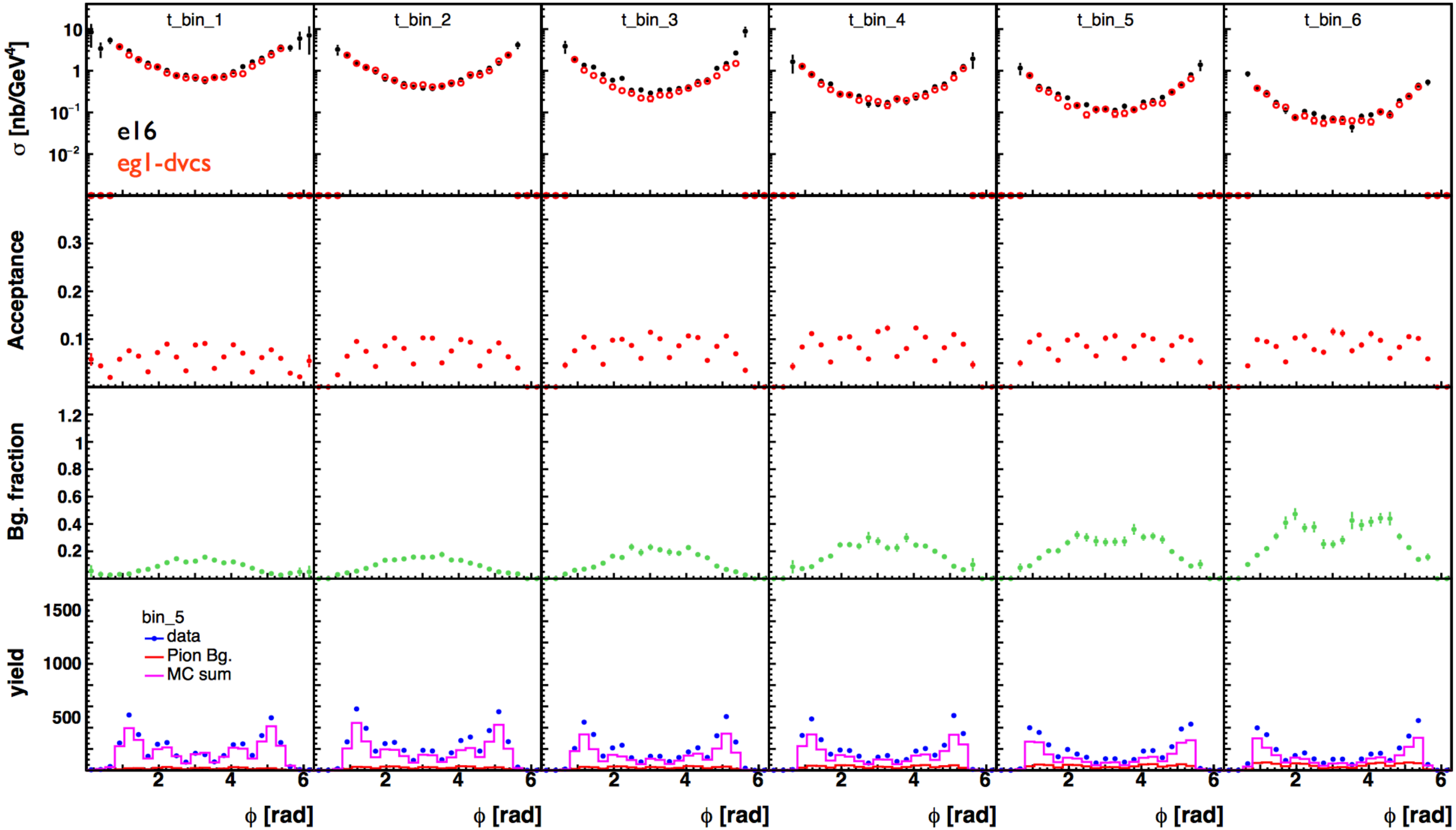


Data - MC comparison (exclusive π^0 , DVCS , MC sum):



$x_{Bj} - [0.17 - 0.20]$

$\theta_{ele} - [25.5 - 45]$



Energy dependence of azimuthal asymmetries

H. Avakian (Jlab)

Deep Processes Working Group Meeting 2016, Nov 3, 2016

Azimuthal distributions in SIDIS

$$\frac{d\sigma}{dx_B\, dy\, d\psi\, dz\, d\phi_h\, dP_{h\perp}^2} = \frac{\alpha^2}{x_B y Q^2} \frac{y^2}{2\,(1-\varepsilon)} \left(1+\frac{\gamma^2}{2x_B}\right) \Big\{ F_{UU,T} + \varepsilon F_{UU,L} + \sqrt{2\,\varepsilon(1+\varepsilon)}\, \cos\phi_h\, F_{UU}^{\cos\phi_h} + \varepsilon \cos(2\phi_h)\, F_{UU}^{\cos 2\phi_h} + \lambda_e \sqrt{2\,\varepsilon(1-\varepsilon)}\, \sin\phi_h\, F_{LU}^{\sin\phi_h} \Big\},$$

$f_1 \otimes D_1$

h.t.

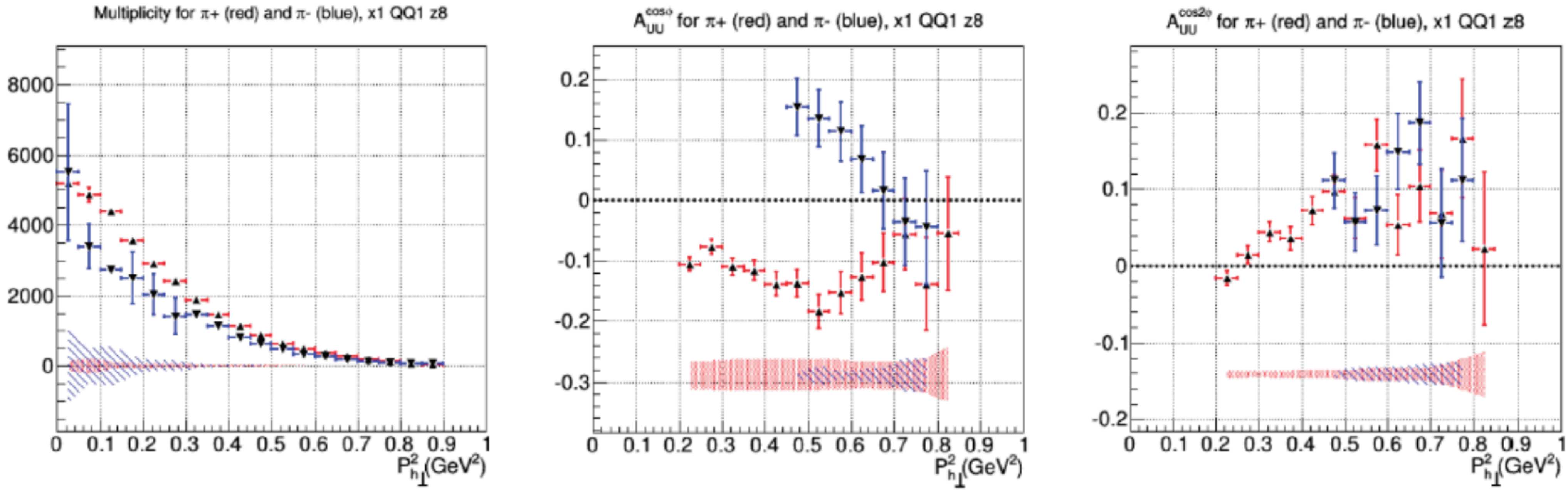
h.t.

$h_1^\perp \otimes H_1^\perp$

h.t.

Fit with $a(1+b\cos\phi_h+c\cos 2\phi_h)$

N. Harrison



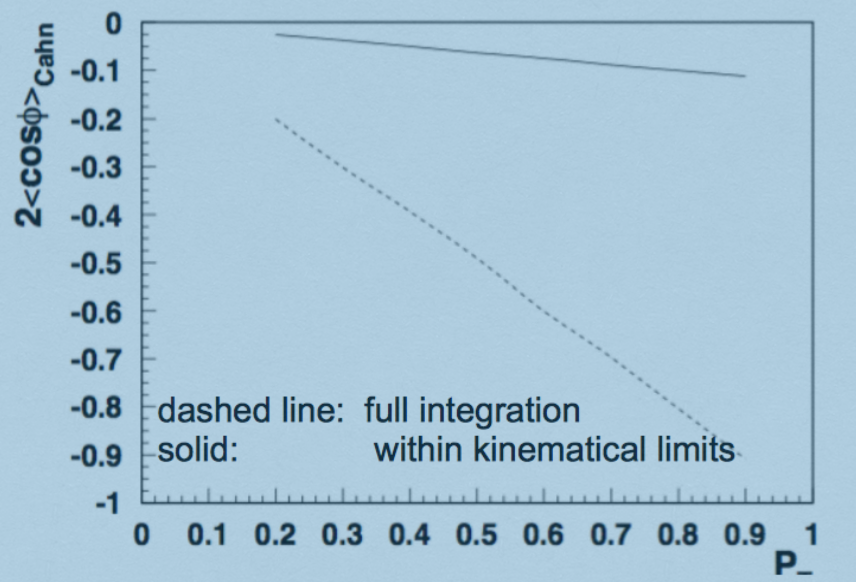
Analyze <cos> and extract Cahn and BM contributions from MC and data.

A self consistent procedure for extraction of TMDs with validation should be used to test the sensitivity of different observables to k_T structure of nucleon.

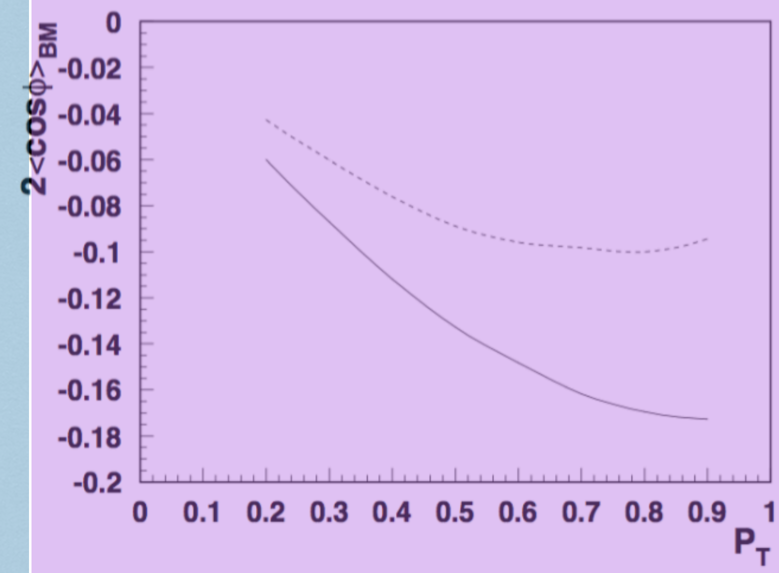
k_T-max: Effect on BM vs Cahn

EVA tests: Cahn vs BM

Boer-Mulders



Cahn



$$F_{UU}^{\cos\phi_h} = \frac{2M}{Q}\,\mathcal{C}\left[\frac{\hat{h}\cdot p_\perp}{zM_h}\frac{k_\perp^2}{M^2}h_1^\perp\, H_1^\perp - \frac{\hat{h}\cdot k_\perp}{M} z f_1 D_1\right]$$

BM contribution seem to be less
sensitive to phase space limitations
Need cross check.

Kinematic limitations due to finite beam energies may change significantly all spin-azimuthal asymmetries (smaller the beam energy, higher affected x-values)!

- DPWG analyses are working their way through the system
- Analysis/extraction frameworks are needed for SIDIS and DVCS
- Run Groups C and F are busy working
- Marco Contalbrigo at this moment becomes the new Deep Processes Working Group Chair