CLAS12 Run Group B

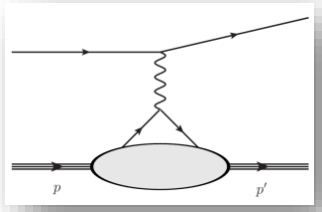
Electroproduction on deuterium with CLAS12

- RG-B experiments
- Overview of the data taking and processing
- Analysis updates and preliminary results
- Outlook and publication plans

Silvia Niccolai, IJCLab Orsay

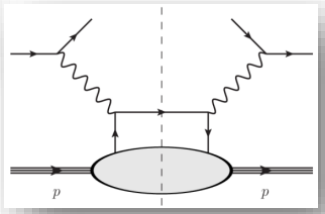
CLAS Collaboration Meeting, 11/10/2020

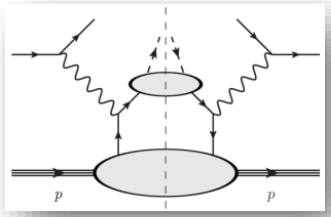
CLAS12 Run Group B: experiments & analyses/PhDs



Elastic Scattering (G^n_M)

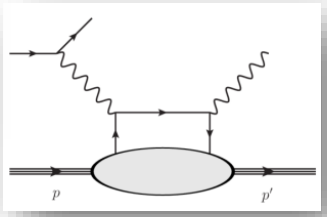
DIS (for SRC and EMC effect)

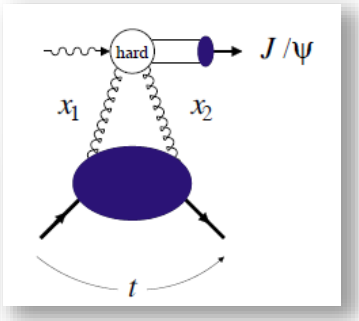




SIDIS (for PDFs and TMDs

nDVCS





J/ψ photoproduction

Run-Group B aims to measure FFs, PDFs, TMDs, GPDs, using **deuteron** as a **neutron target**
→ Quark-flavor separation, combining with proton results

E12-07-104	Neutron magnetic form factor
E12-09-007a	Study of parton distributions in K SIDIS
E12-09-008	Boer-Mulders asymmetry in K SIDIS
E12-11-003	Deeply virtual Compton scattering on the neutron
E12-09-008b	Collinear nucleon structure at twist-3 in dihadron SIDIS
E12-11-003a	In medium structure functions, SRC, and the EMC effect
E12-11-003b	Study of J/ψ photoproduction off the deuteron
E12-11-003c	Quasi-real photoproduction on deuterium (*)

L. Basheen (FIU), GMn
A. Hobart (IJCLab Orsay), nDVCS, pDVCS
P. Naidoo (Glasgow), ed→enπ^0
B. Tumeo (USC), J/ψ
Student TBD from Yerevan, J/ψ
E. P. Segarra (MIT), BAND experiment
R. C. Torres (MIT), BAND experiment
C. Fogler (ODU), BAND experiment

+ post-docs and undergrads: A. Movsisyan (INFNFe), O. Soto (LNF), J. Dickovick (Fairfield U)

(*) Joined RGB from fall run onwards

Run Group B running time

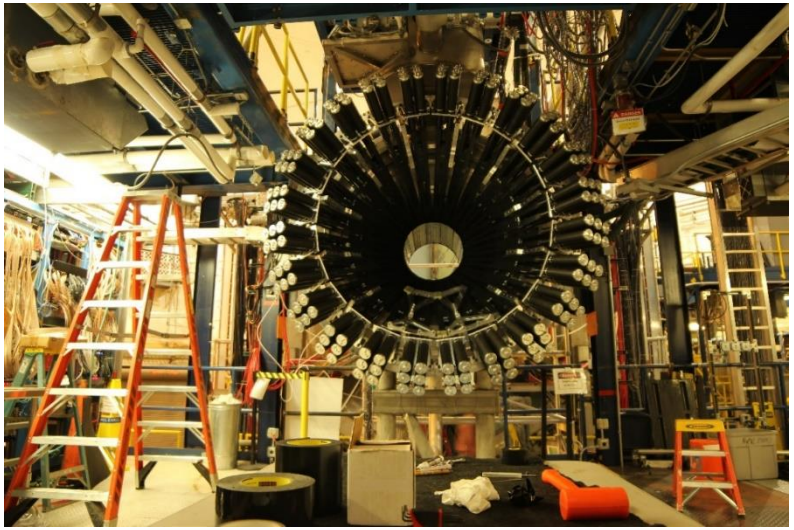
Scheduled beam time:
Spring: February 6th - March 25th 2019
Fall: December 3rd –20th 2019
Winter: January 6th – 30th 2020

Experimental setup:
- Baseline CLAS12
- Liquid deuterium target
- Forward Tagger
- RICH (1 sector)
- Central Neutron Detector
- BAckward Neutron Detector

43.3 B triggers collected at 3 different beam energies:
- 10.6 GeV (9.7 B inbending) **spring**
- 10.2 GeV (11.7 B inbending) **spring**
- 10.4 GeV (9 B outbending) **fall, (**12.9 B inbending) **winter**

Average beam polarization ~86%

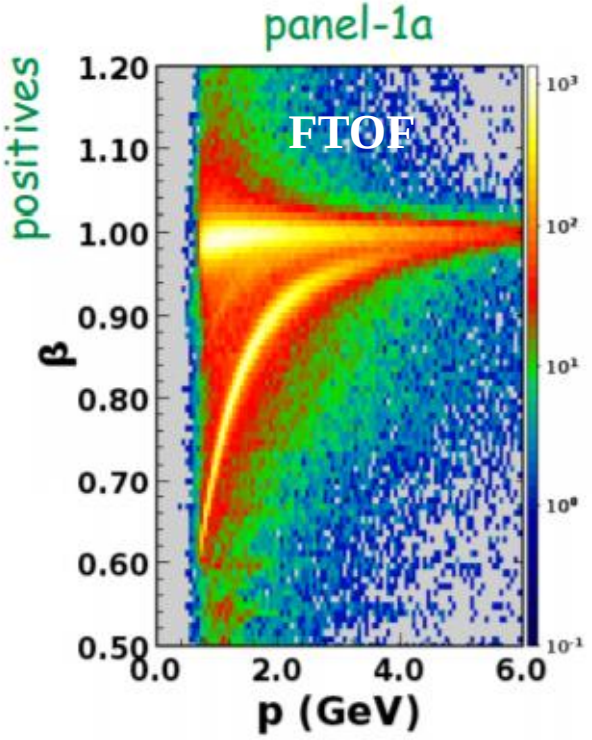
38.9 total PAC days according to ABUs
→ 43.2% of the approved 90 PAC days
51 PAC days left→ approved by Jeopardy PAC
Rating mantained (A and H.I.)

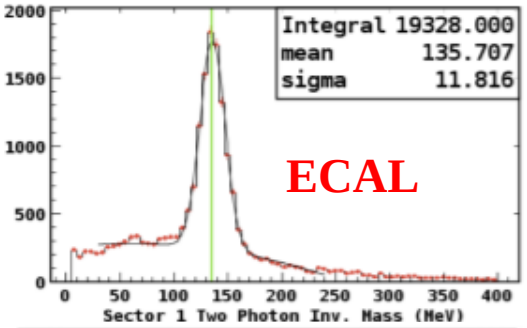


Status of data processing:
- spring dataset calibrated
- spring "cooking" completed (Sep 2nd)
- fall dataset: **pass-1 review just passed**
- winter: calibrations underway

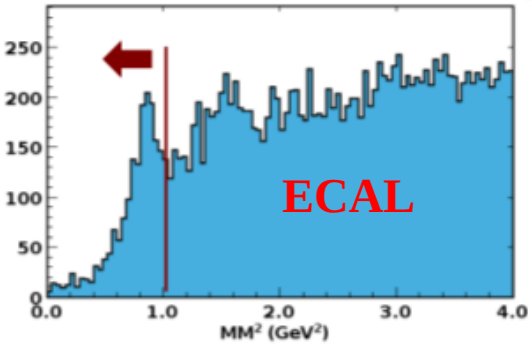
*All results presented in this talk come from the **spring** dataset*
~50% of all the data taken so far

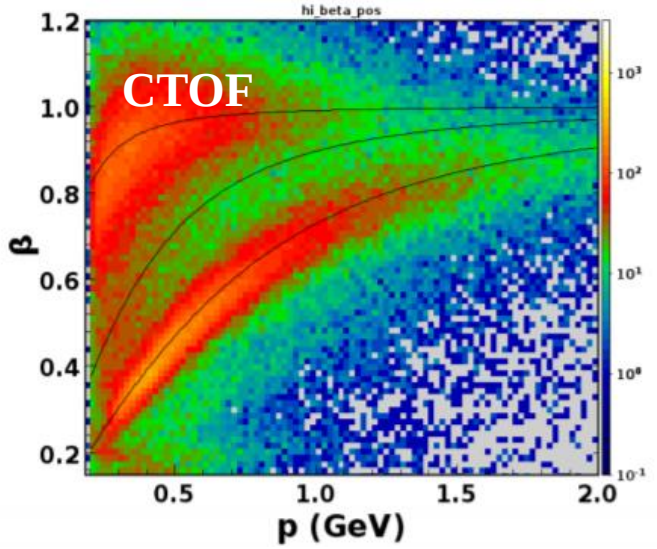
Data quality of RGB data

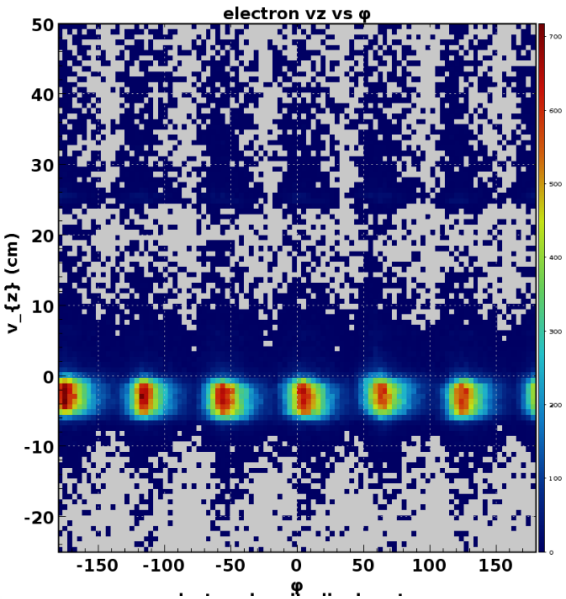


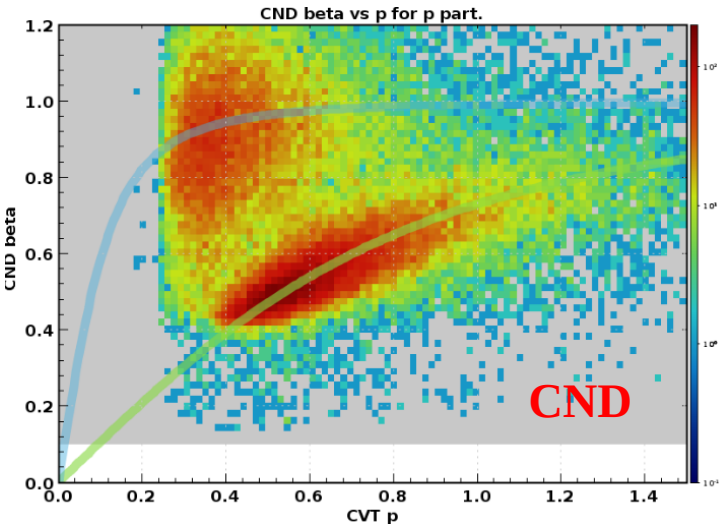


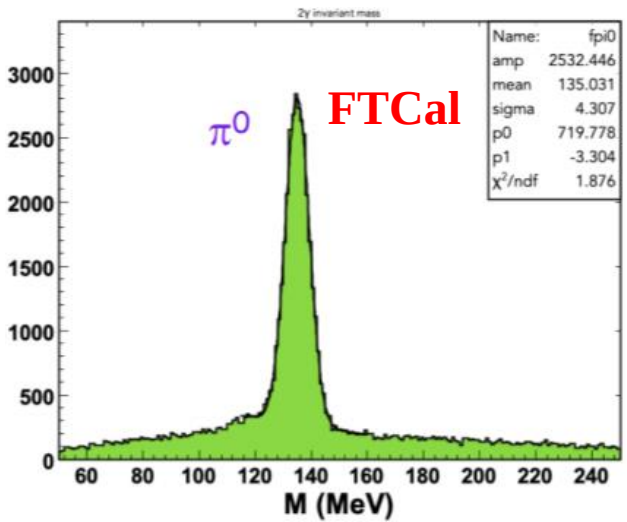
tagged neutrons d(e,e'π⁺)nn











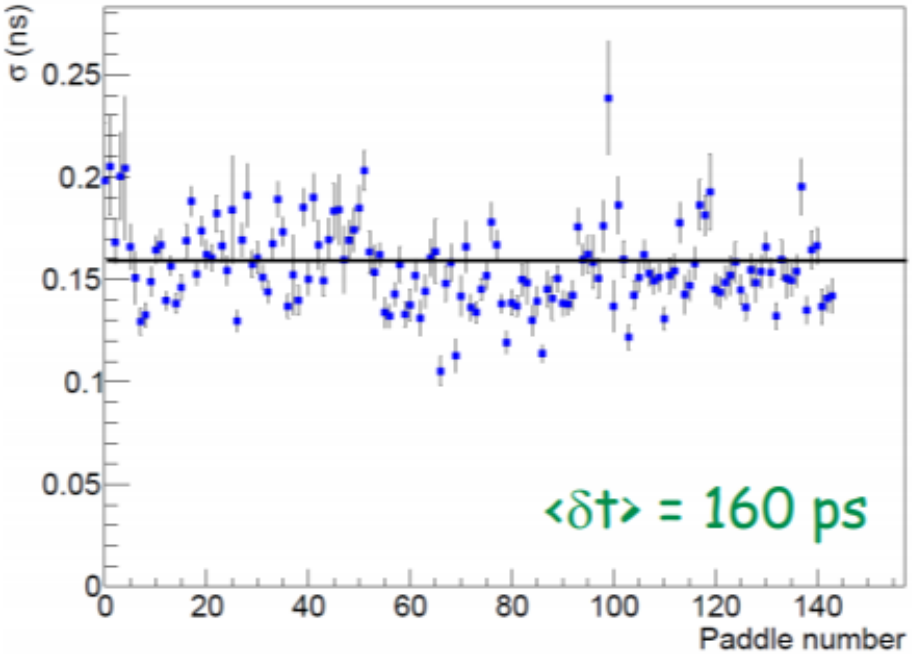
CND: performances with CLAS12 data

Purpose: detect the **recoiling neutron in nDVCS**
Requirements/performances**:**
- good neutron/photon separation for $0.2<p_n<1$ GeV/c
→ ~150 ps time resolution ✓ (~160 ps)
- momentum resolution $\delta p/p < 10\%$ ✓
- neutron detection efficiency ~10% ✓

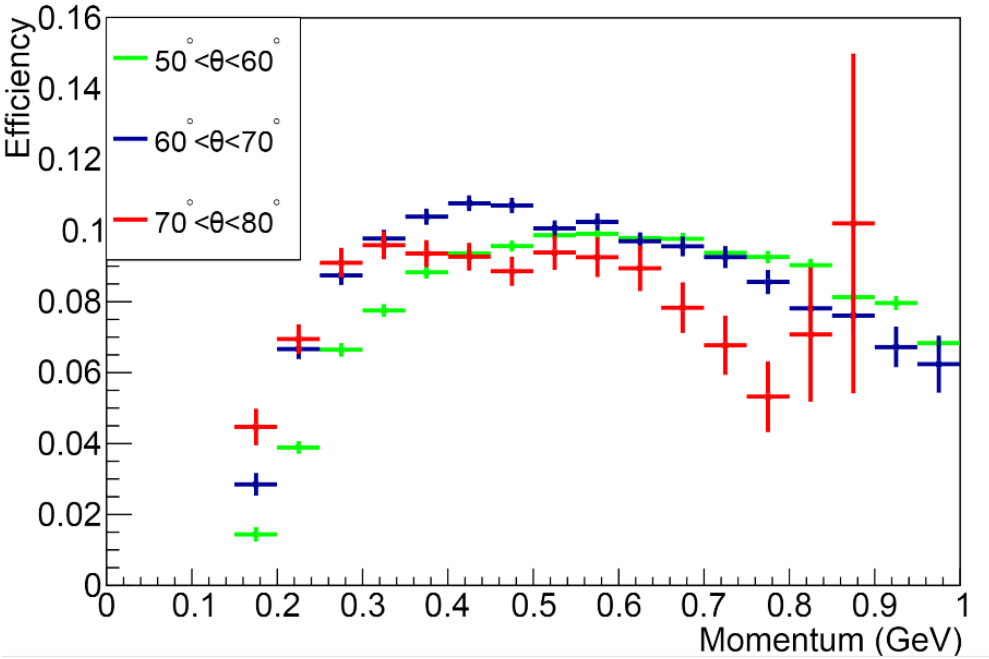
CND design: scintillator barrel - 3 radial layers, 48 bars per layer **coupled two-by-two** downstream by a **"u-turn" lightguide,** 144 long light guides with **PMTs** upstream

S.N. *et al.*, NIM A 904, 81 (2018)
P. Chatagnon *et al.*, NIM A 959 (2020) 163441

Timing resolution per paddle (RGB data)



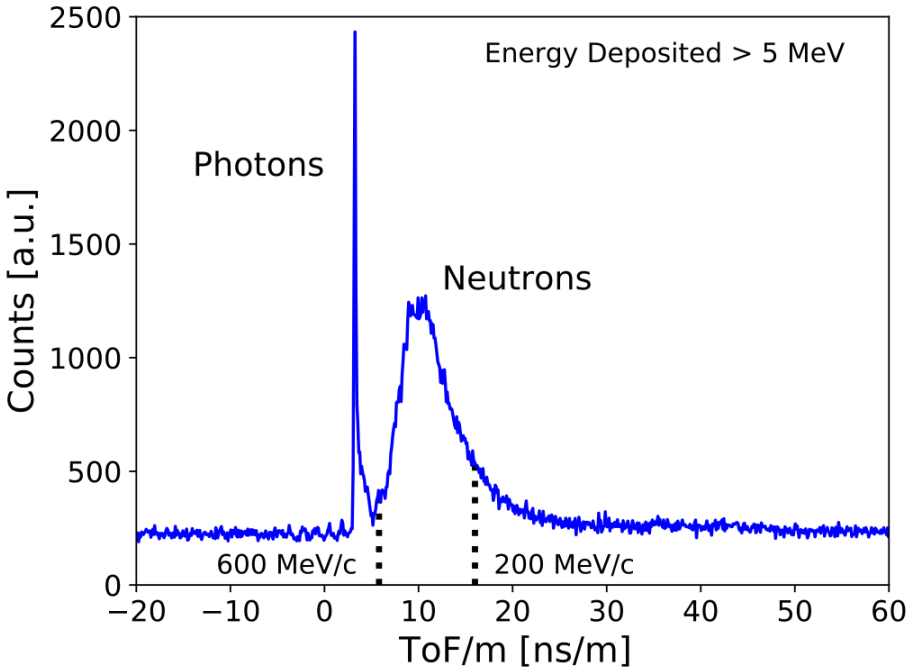
Neutron efficiency from ep→e'nπ⁺ (RGA data)

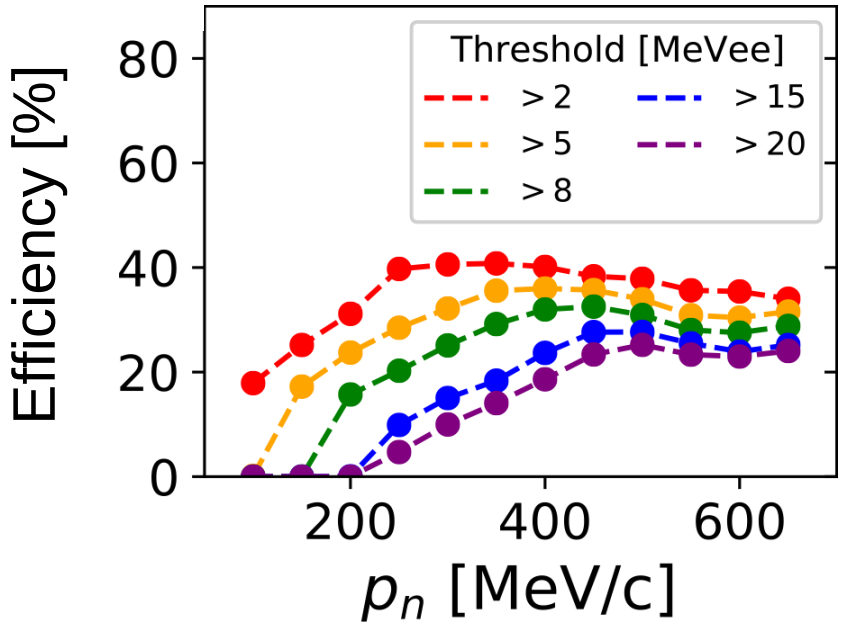


BAND: performance with CLAS12

Goal: detect recoil spectator neutrons from DIS on proton in deuterium

- requires photon separation for $p_n \in [0.2,0.6]$ GeV/c
- requires neutron efficiency ~30%





E.P. Segarra et al., NIM A 978 (2020)

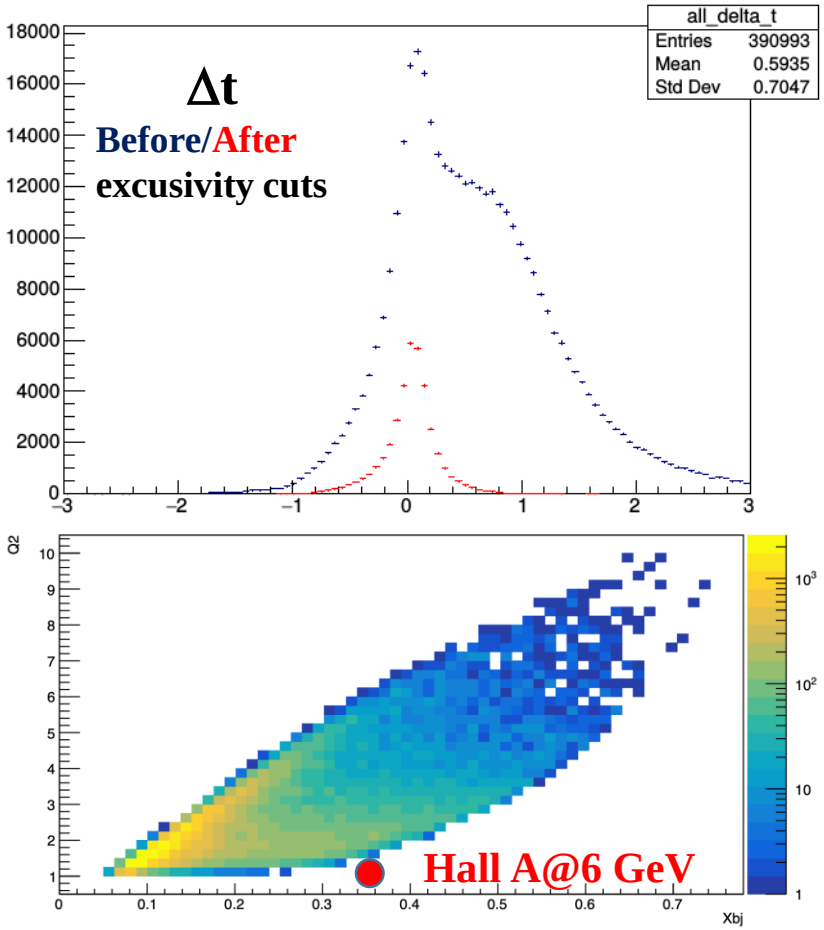
nDVCS with RGB data

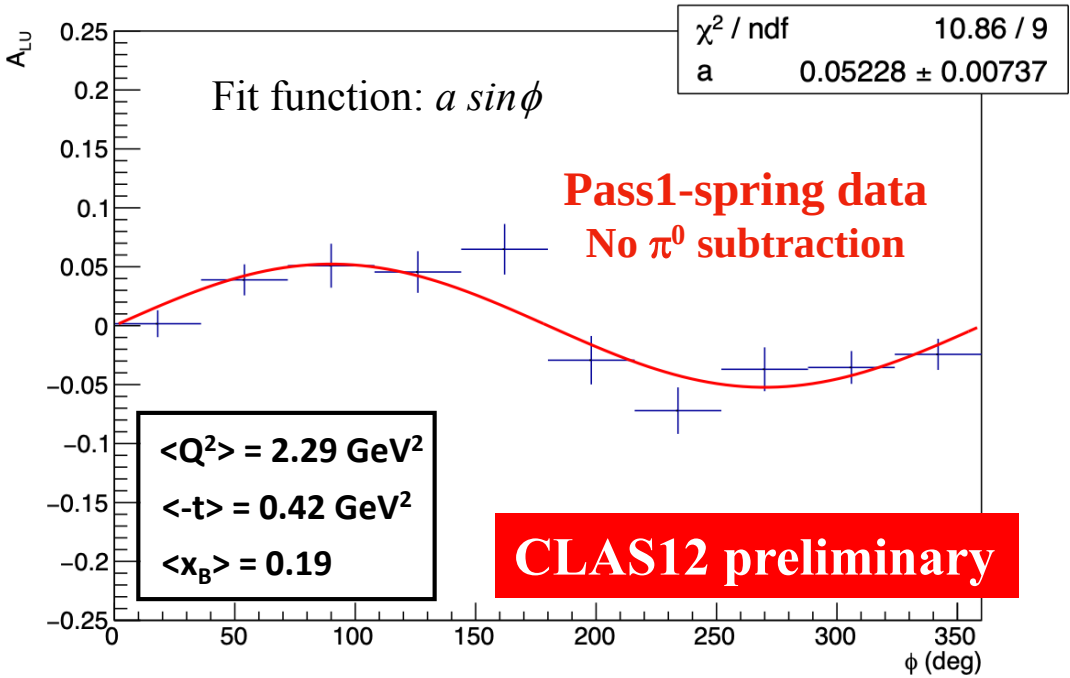
$\vec{e}d \rightarrow en\gamma(p)$

First-time measurement of BSA for nDVCS with exclusive final state selection:

- Events with at least one **electron, neutron, photon**
- The chosen combination in each event is the one satisfying at best the exclusivity criteria on:

M_X, p_X, E_X ($ed \rightarrow en\gamma X$), Δt, $\Delta\phi$, $\theta_{\gamma X}$





- 55188 nDVCS event candidates
- Raw BSA integrated over all kinematics and topologies
- **10.6 GeV and 10.2 data combined**
- Includes **a charged-particle veto** based on CND and CTOF information (MC based).
- Work ongoing on improved veto (neural networks trained on real data).
- Work ongoing on kinematic corrections, π^0 subtraction, fiducial cuts, etc…

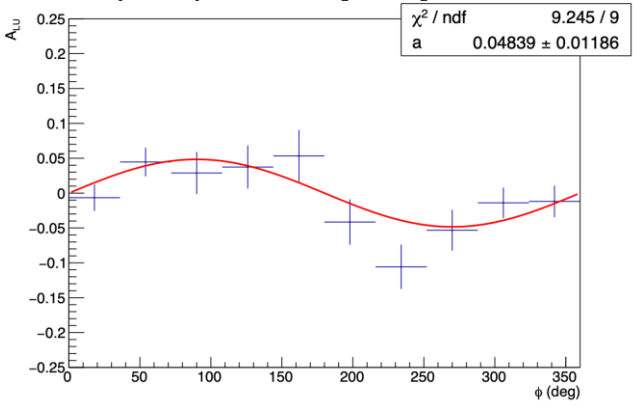
A. Hobart, S. N. (IJCLab Orsay)

See Adam's talk Wednesday 12PM

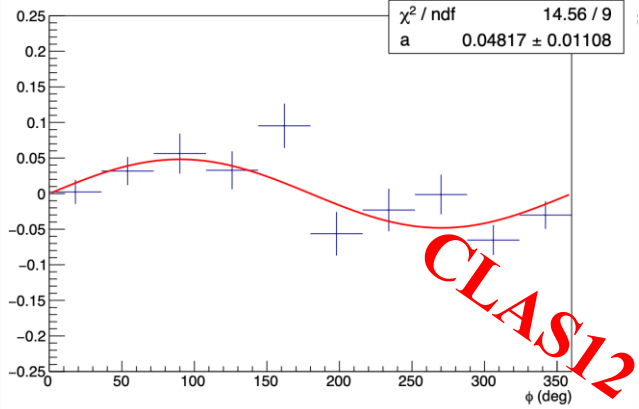
nDVCS raw BSA vs ϕ in 1-dim. bins

First-time measurement

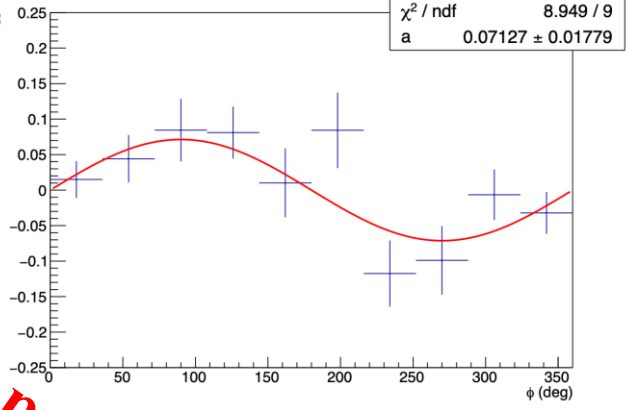
Q^2 bins (GeV^2) [1,1.8]



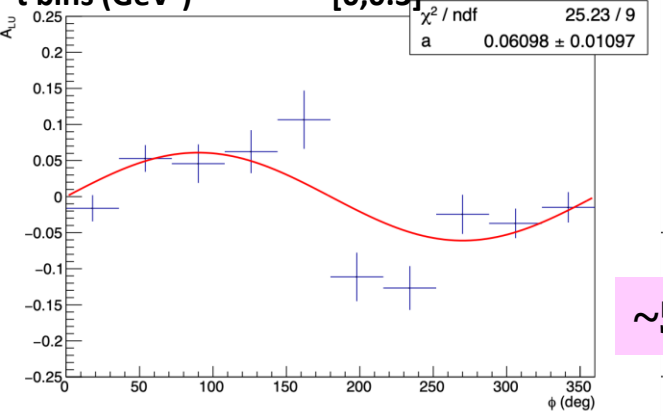
[1.8,3]



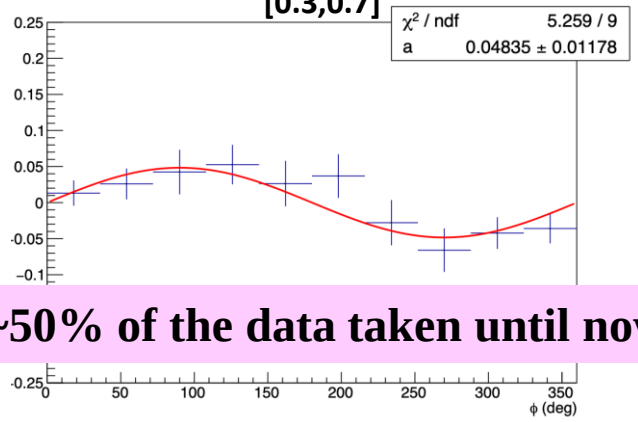
[3,inf]



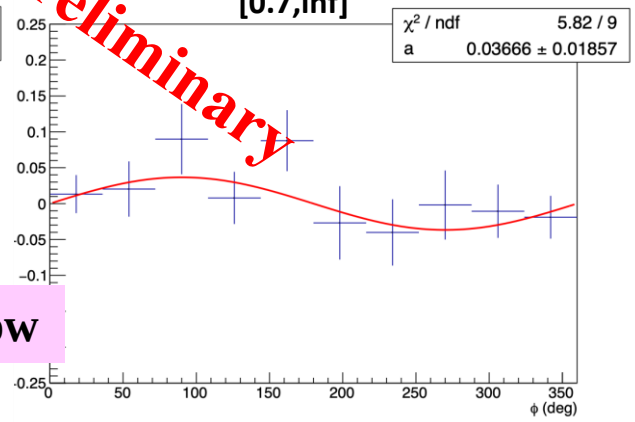
-t bins (GeV^2) [0,0.3]



[0.3,0.7]



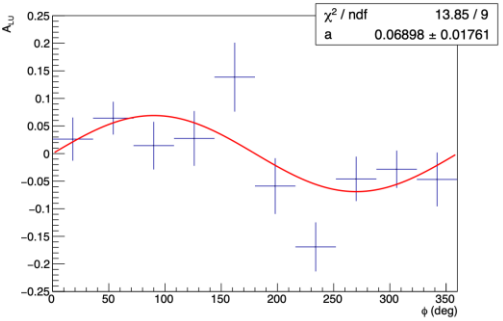
[0.7,inf]



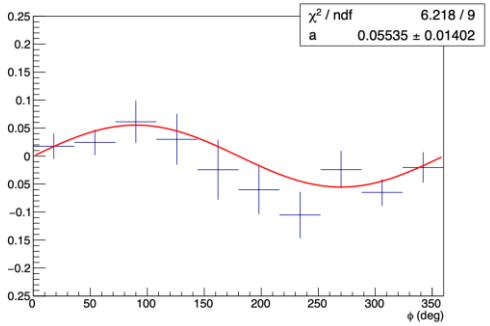
CLAS12 preliminary

~50% of the data taken until now

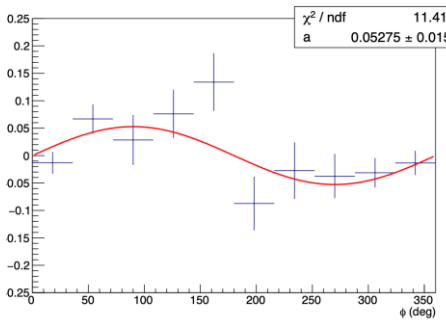
x_B bins [0.05,0.1]



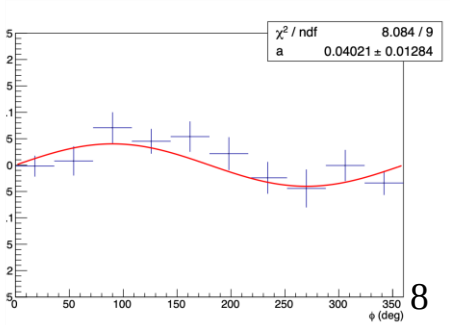
[0.1,0.14]



[0.14,0.2]



[0.2,inf]

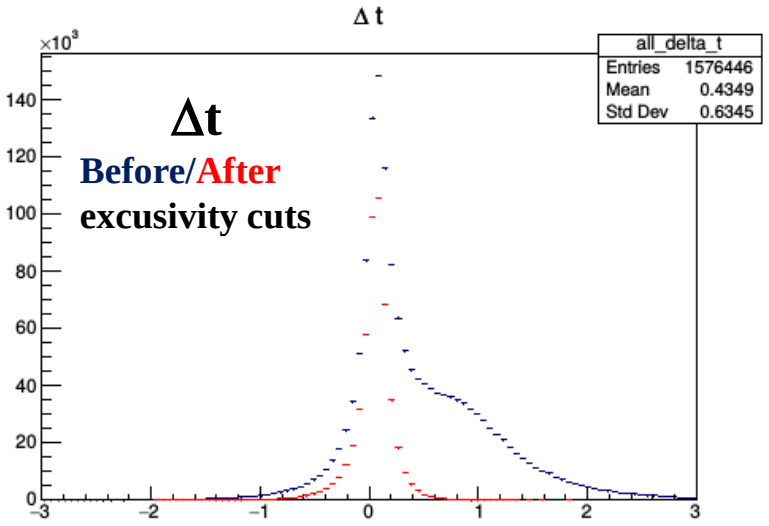


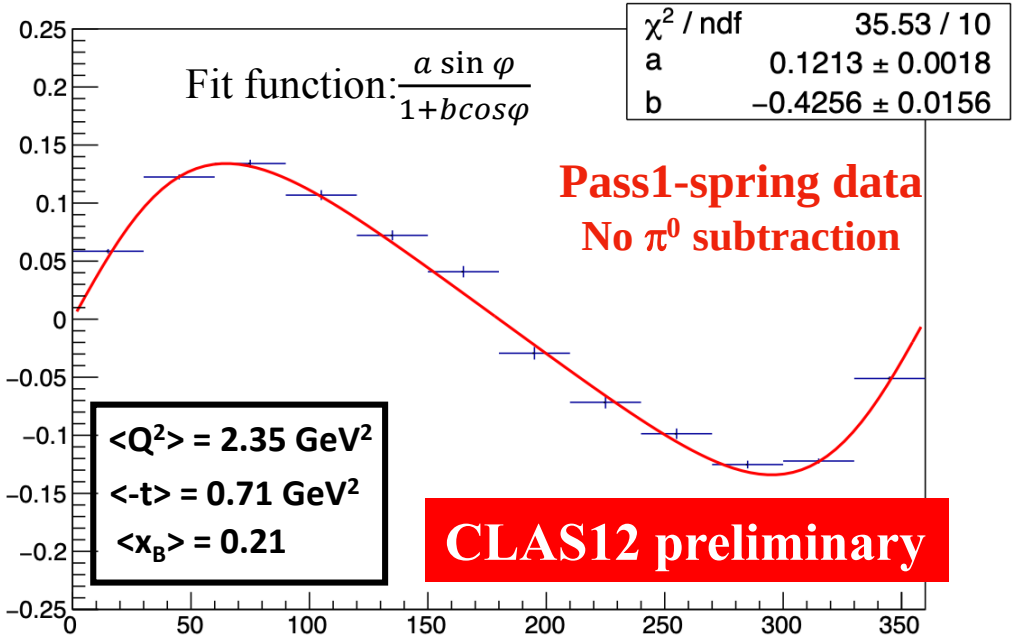
Incoherent pDVCS on deuterium

$\vec{e}d \rightarrow ep\gamma(n)$

- Events with at least one **electron, proton, photon** are selected (PID + kinematic cuts)
- The chosen combination in each event is the one satisfying at best the exclusivity criteria:

M_X, p_X, E_X ($ed \rightarrow ep\gamma X$), Δt, $\Delta\phi$, $\theta_{\gamma X}$





- 2020720 identified pDVCS candidates
- Raw BSA integrated over all kinematics and detection topologies
- **Compatible with raw BSA from pDVCS in RGA**
- **nDVCS and pDVCS yields scale as expected: $(CS*eff)_p \sim 40 (CS*eff)_n$**
- Work ongoing on π^0 subtraction, fiducial cuts, etc…

First-time measurement

Interest of pDVCS on deuterium:

- In itself: nuclear medium effects on proton structure
- For nDVCS: to evaluate FSI, comparing to free pDVCS

A. Hobart, S. N. (IJCLab Orsay)

See Adam's talk Wednesday 12PM

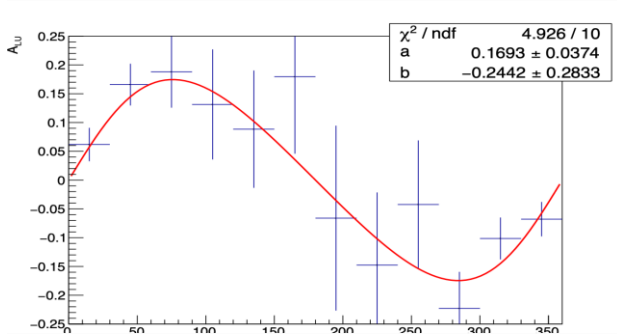
pDVCS raw BSA vs ϕ in 3-dim. bins

Q^2 bins (GeV^2)

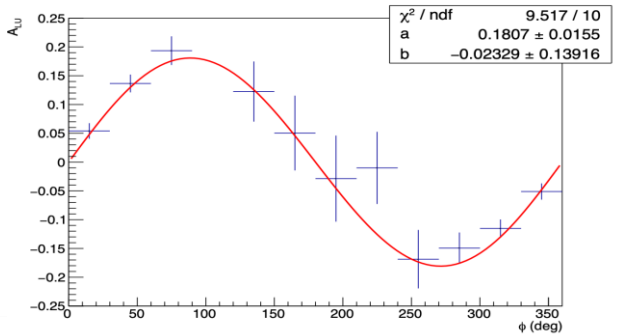
[4,inf]

First-time measurement

-t bin [0,0.2] (GeV^2)

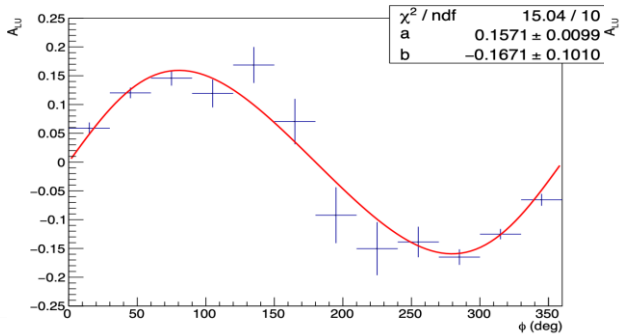


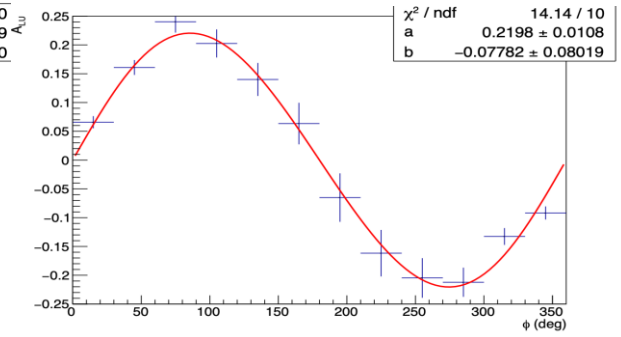
[3,4]



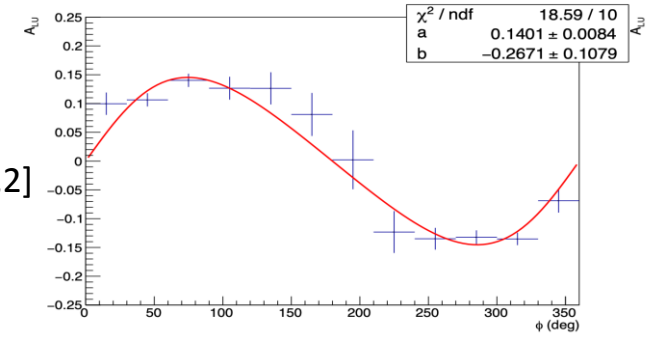
CLAS12 preliminary

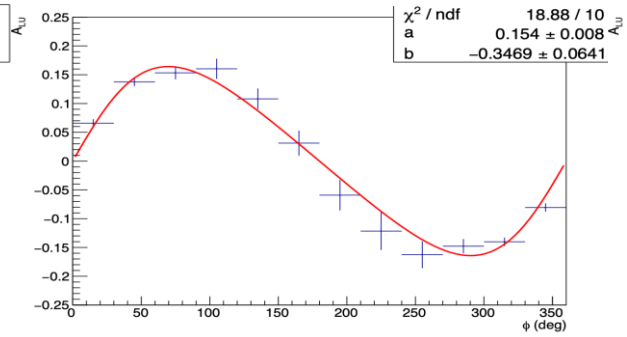
[2,3]

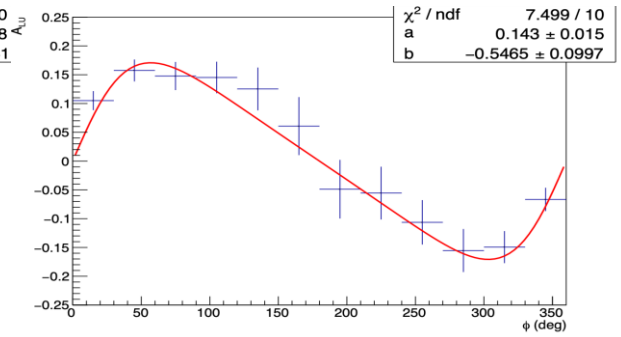




[1,2]







[0.05,0.1] [0.1,0.17] [0.17,inf] x_B bins

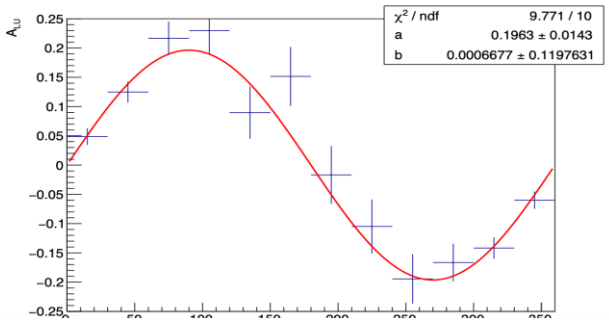
pDVCS raw BSA vs ϕ in 3-dim. bins

Q^2 bins (GeV^2)

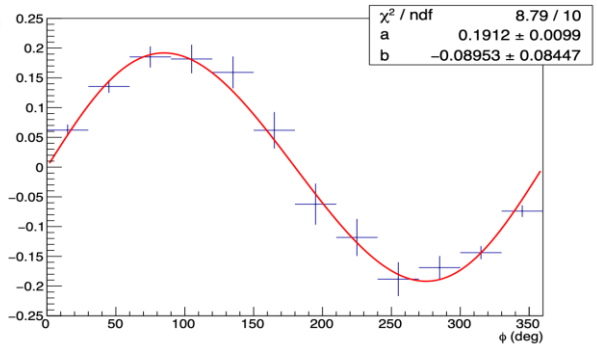
[4,inf]

First-time measurement

-t bin [0.2,0.4] (GeV^2)

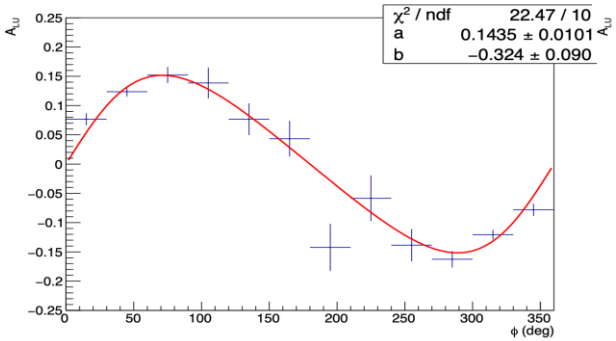


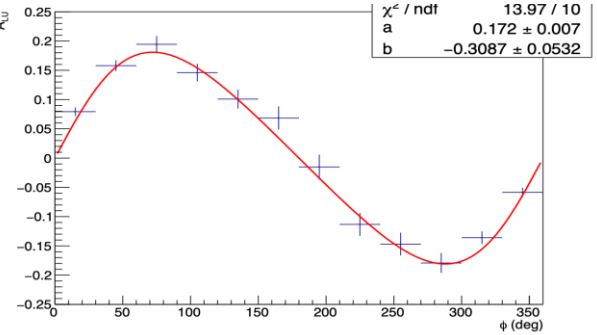
[3,4]



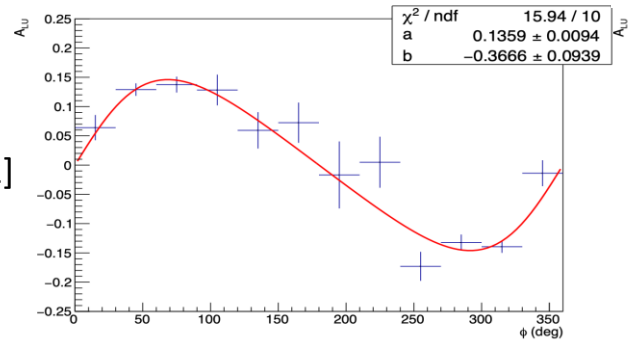
CLAS12 preliminary

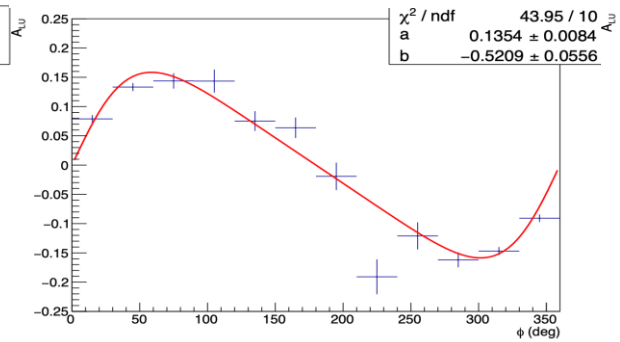
[2,3]

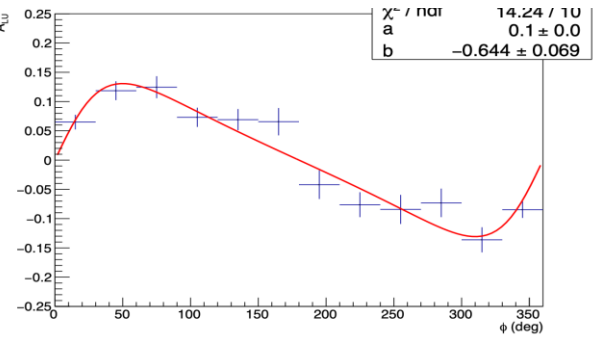




[1,2]







[0.05,0.1] [0.1,0.17] [0.17,inf] x_B bins

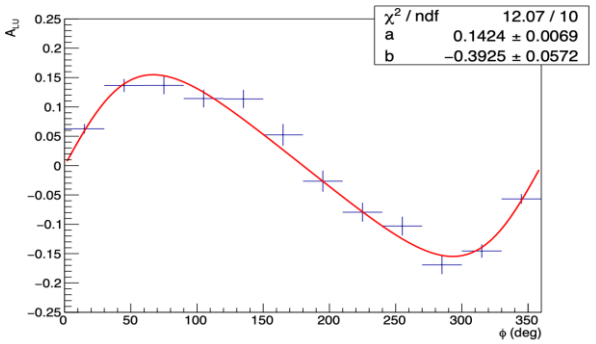
pDVCS raw BSA vs ϕ in 3-dim. bins

Q^2 bins (GeV^2)

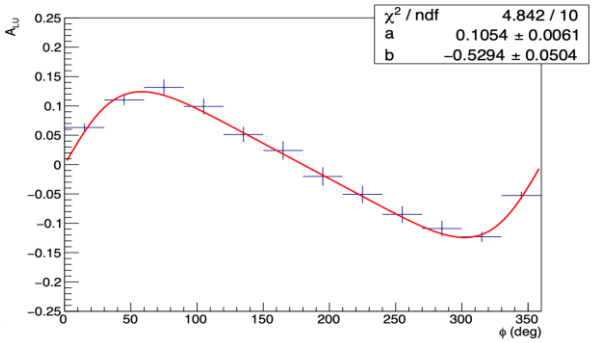
[4,inf]

First-time measurement

-t bin [0.4,inf] (GeV^2)

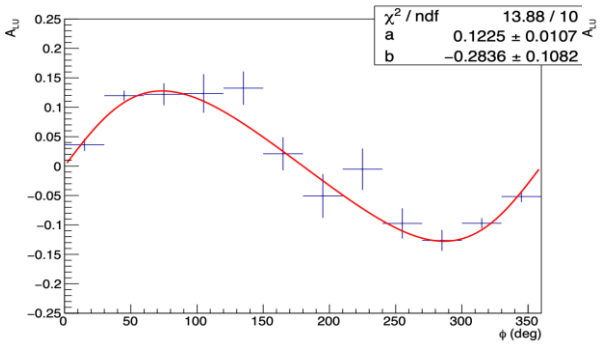


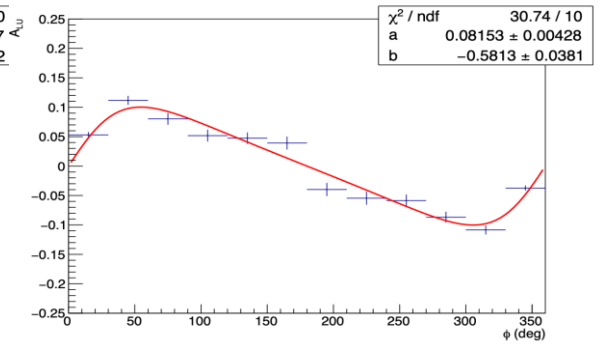
[3,4]



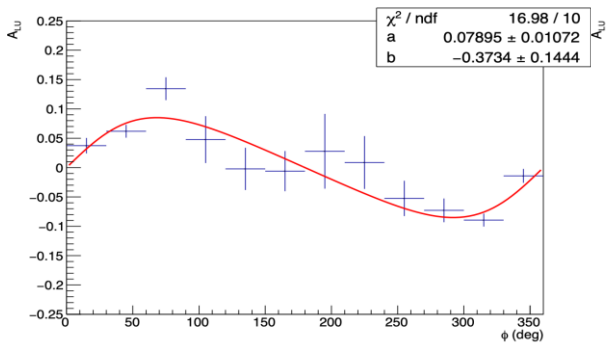
CLAS12 preliminary

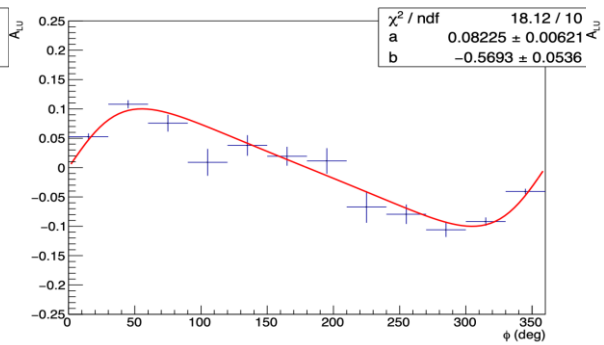
[2,3]

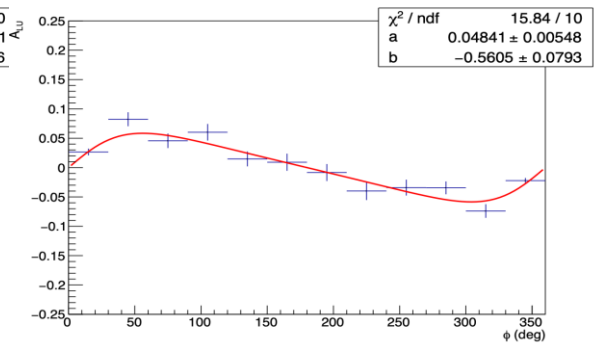




[1,2]



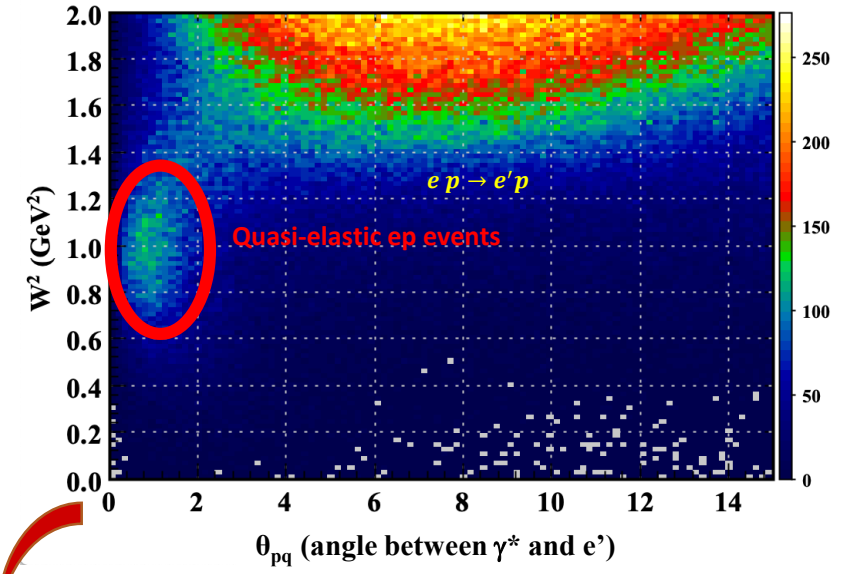




[0.05,0.1] [0.1,0.17] [0.17,inf] x_B bins

Measurement of the Neutron Magnetic Form Factor G_M^n at High Q^2 Using the Ratio Method on Deuterium

Goal: Extract G_M^n at high Q^2 using the ratio of quasi-elastic e-n and quasi-elastic e-p on deuteron: $R = \frac{d(e,e'n)p}{d(e,e'p)n}$



L.Baashen, B. Raue (FIU), G. Gilfoyle (U. Rich.), L.C. Smith (UVA)

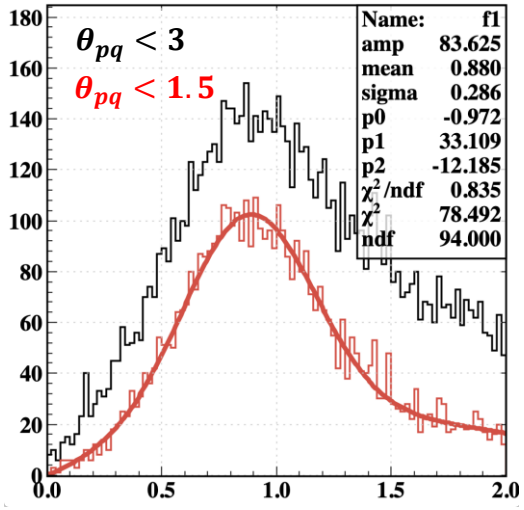
Analysis status:

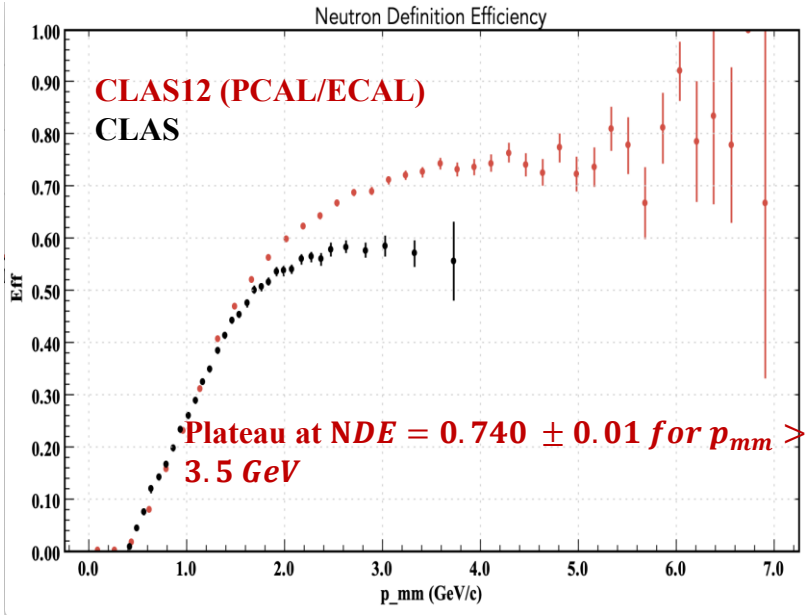
- Using **RG-B** data from spring 2019 to extract **quasi-elastic ep and en events**
- Using **RG-A** data from fall 2018 to measure **neutron detection efficiency** with the **ep→eπ⁺n** channel

Quasi-elastic event selection:

1. Apply cut on $W^2 < 2.0$.
2. Apply cut on θ_{pq} (angle between the virtual photon and scattered nucleon 3-momenta) to reduce inelastic background.

Quasi-elastic ep event at $Q^2 = 5.25$ GeV^2



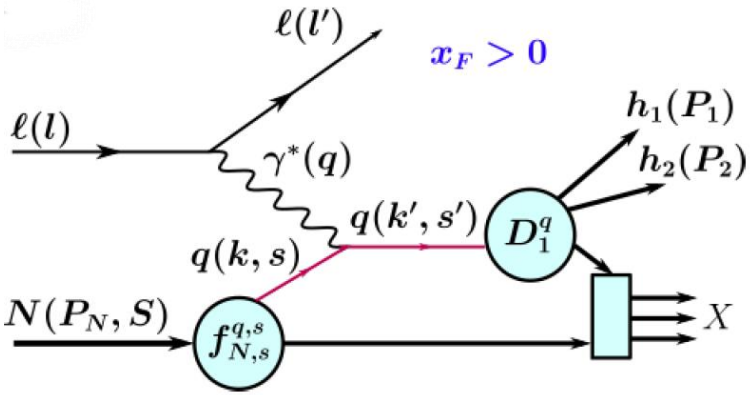


Di-hadron Multiplicities

e N → e' π^+ π^- X

Number of di-hadron pairs per DIS electron

$$M(x_B, z, M_{\pi\pi}; Q^2) = \frac{d\sigma^{dh}/dx_B dz dM_{\pi\pi} dQ^2}{d\sigma^{DIS}/dx_B dQ^2}$$



$$d\sigma^{dh} \propto \sum_q f_{1,q}(x_B) D_{1,q}^{dh}(z, M_{\pi\pi})$$

Di-hadron unpolarized Fragmentation Function (FF)
It enters in the denominator of every asymmetry

Assuming isospin symmetry, the analysis of <u>hydrogen</u> and <u>deuterium</u> data allows the extraction of u and d FF

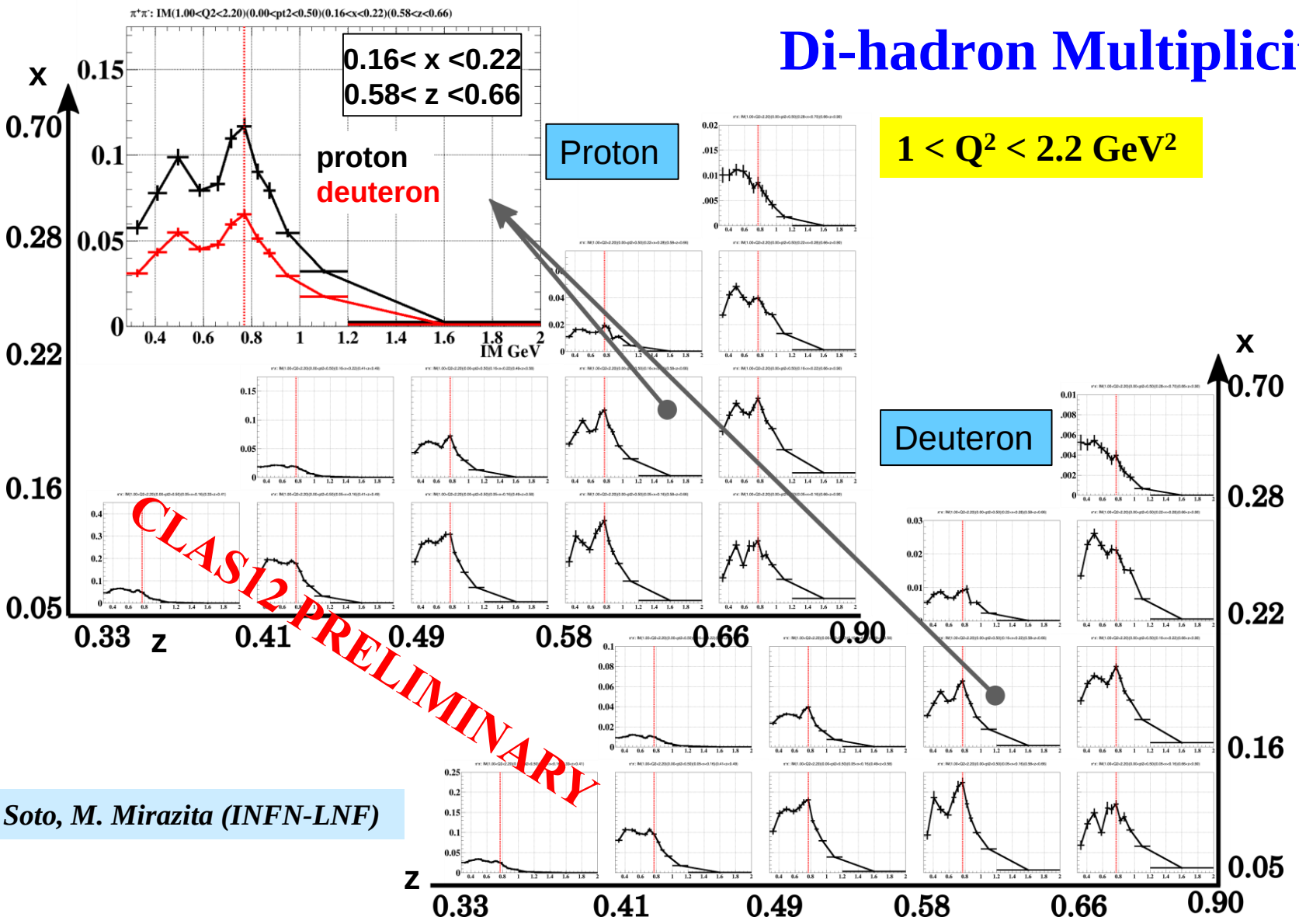
$$D_{1,u}^{dh} = 3\frac{M^p\left(\frac{4}{9}f_{1,u} + \frac{1}{9}f_{1,d}\right) - \frac{1}{9}M^d\left(f_{1,u} + f_{1,d}\right)}{K_f f_{1,u}}$$

$$D_{1,d}^{dh} = 3\frac{\frac{4}{9}M^d\left(f_{1,u} + f_{1,d}\right) - M^p\left(\frac{4}{9}f_{1,u} + \frac{1}{9}f_{1,d}\right)}{K_f f_{1,d}}$$

K_f → kinematic factors

The PDF f_{1q} of the proton are known

Di-hadron Multiplicities



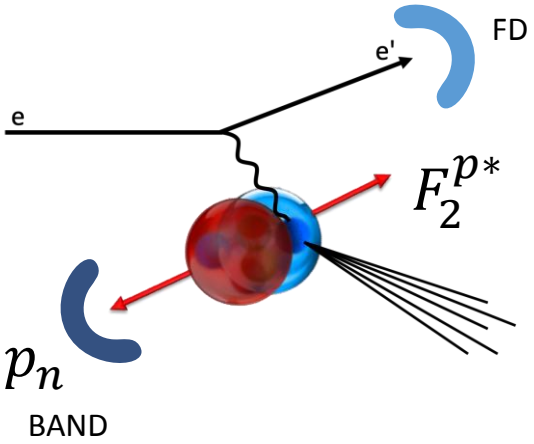
O. Soto, M. Mirazita (INFN-LNF)

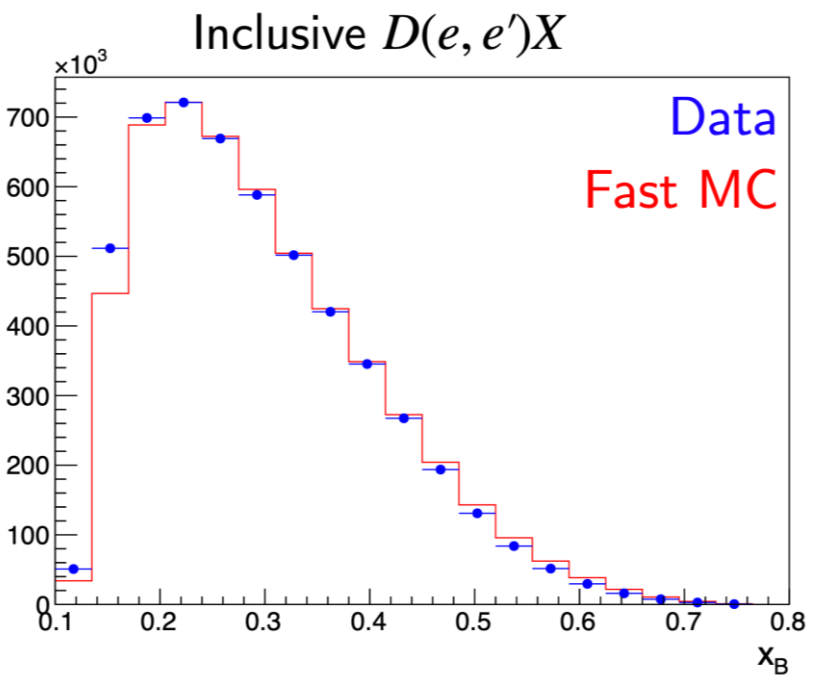
- **4D analysis in x_B, z, $M_{\pi\pi}$ and Q^2**
- **DIS cuts: $Q^2 > 1$, $W > 2$, $y<0.8$**
- **SIDIS cuts: $x_F^{+/-} > 0$, $0.1 < z < 0.95$, $MM>1.1$**

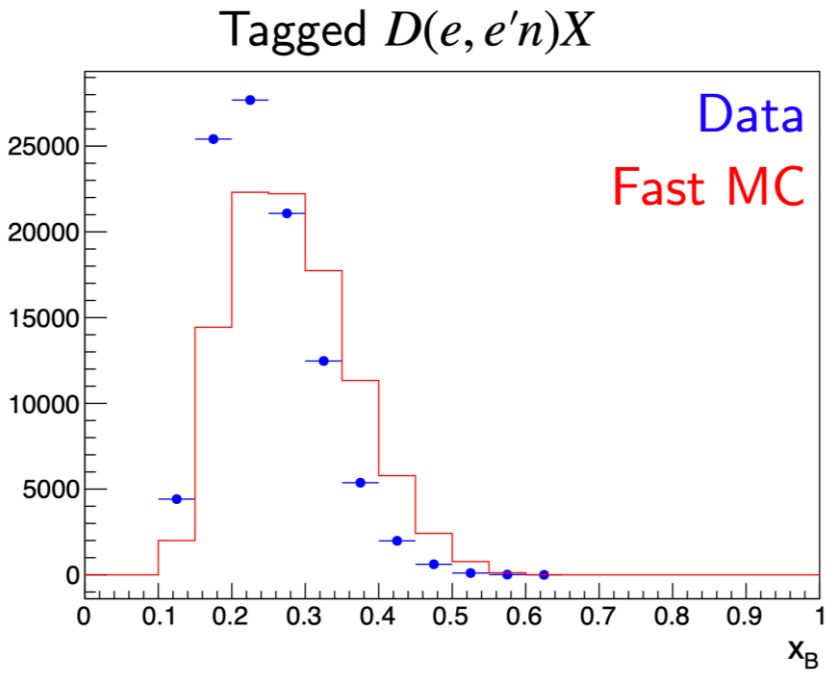
$$4M^p - M^d \rightarrow D_1^u$$

$$4M^d - M^p \rightarrow D_1^d$$

Study bound proton structure by tagging neutron







Most recent progress:

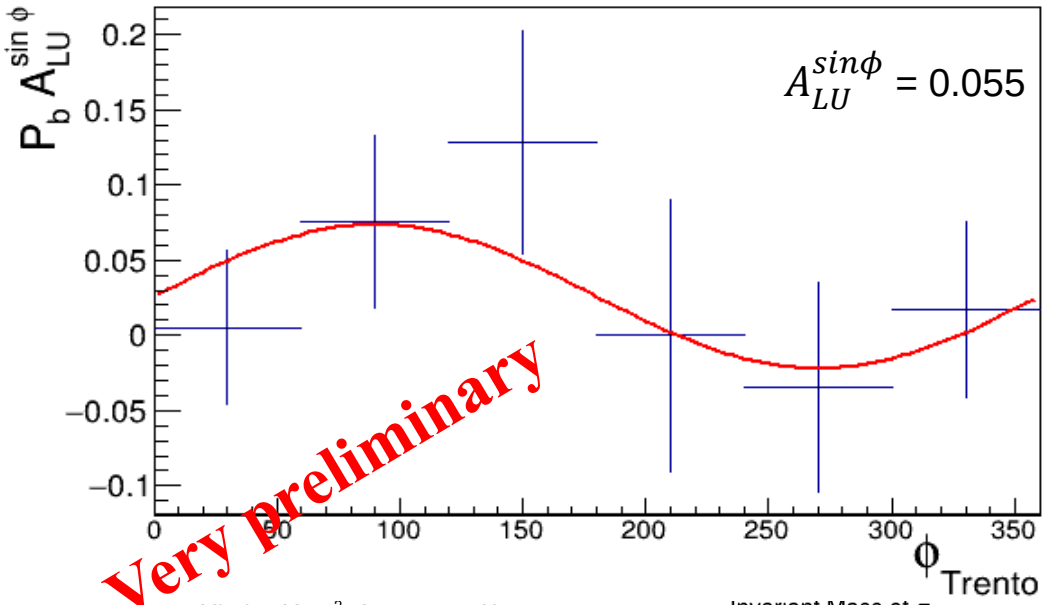
- BAND implemented in GEMC
- on path to extract efficiency
- consistent inclusive and tagged generators implemented
- large differences in tagged spectra

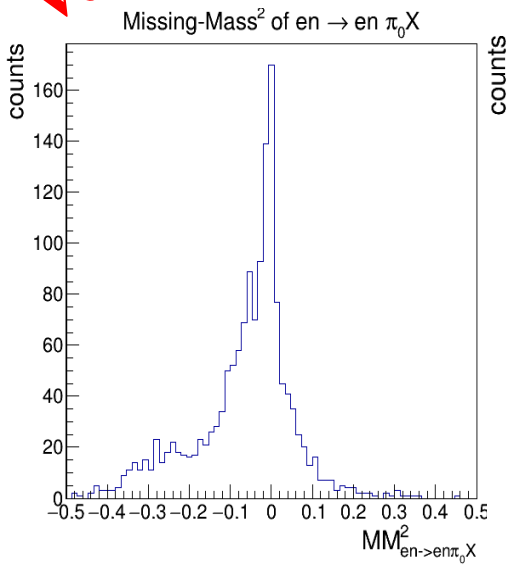
Hard exclusive π_0 production on the neutron

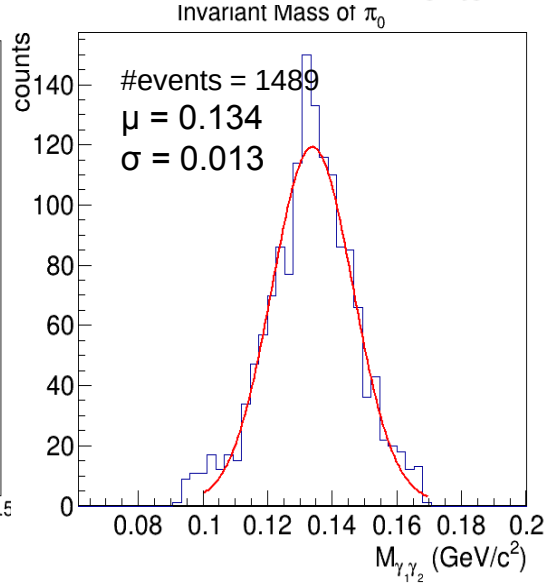
Paul Naidoo & Daria Sokhan – University of Glasgow

- **Channel: eD → e'n'π_0($p_{spect.}$)**
- Motivation:
  - DVCS and DVMP with proton and neutron targets needed for **flavour separation of GPDs**
  - Exclusive π_0 production is sensitive to **transversity** GPDs
- Cuts (work in progress):
  - 3σ π_0 mass
  - $\theta_{e\gamma} > 8^\circ$
  - $\delta\Phi_{Trento} < 5^\circ$
  - $MP_{eD->e'p'\gamma\gamma} < 0.7GeV$
  - $Q^2 > 1\ GeV^2/c^4$
  - $-t < 1\ GeV^2/c^4$
- Optimisation of exclusivity cuts ongoing.
- More statistics needed for higher-precision result.

First-time measurement





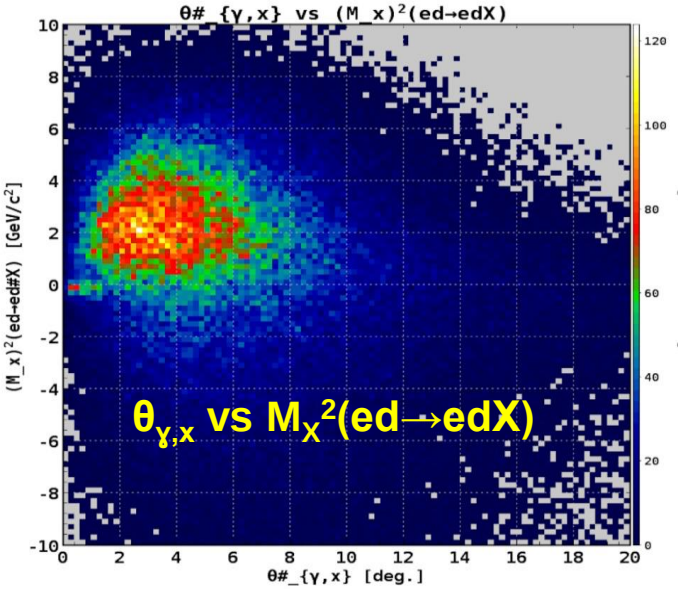


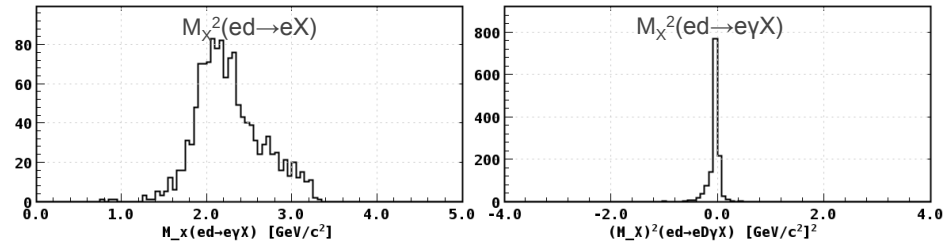
J. Dickovick,
A. Biselli
B. (Fairfield U.)

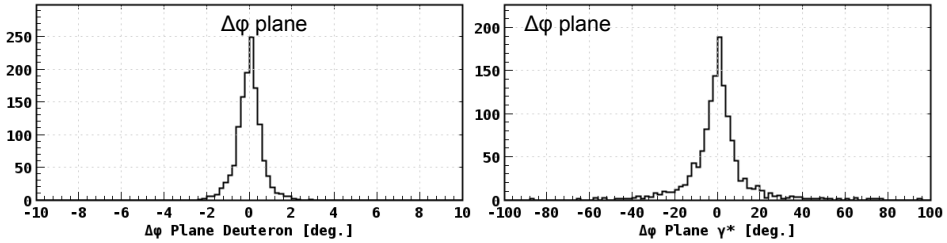
Coherent Deuteron DVCS

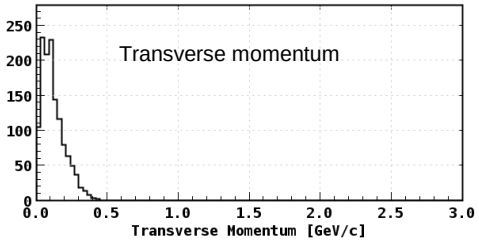
$\vec{e}d \rightarrow ed\gamma$

- 35 runs - pass0v16 ("**DNP cooking", ~25% of spring**)
- ed → edγ
- Exclusivity cuts for events with γ in FT:
  - $E_X(ed \rightarrow ed\gamma X) < 2$ GeV
  - $p_t < 0.5$ GeV/c
  - 2-dimensional cut on $\theta_{\gamma,x}$ vs $M_X^2(ed \rightarrow edX)$
- Similar cuts for FD

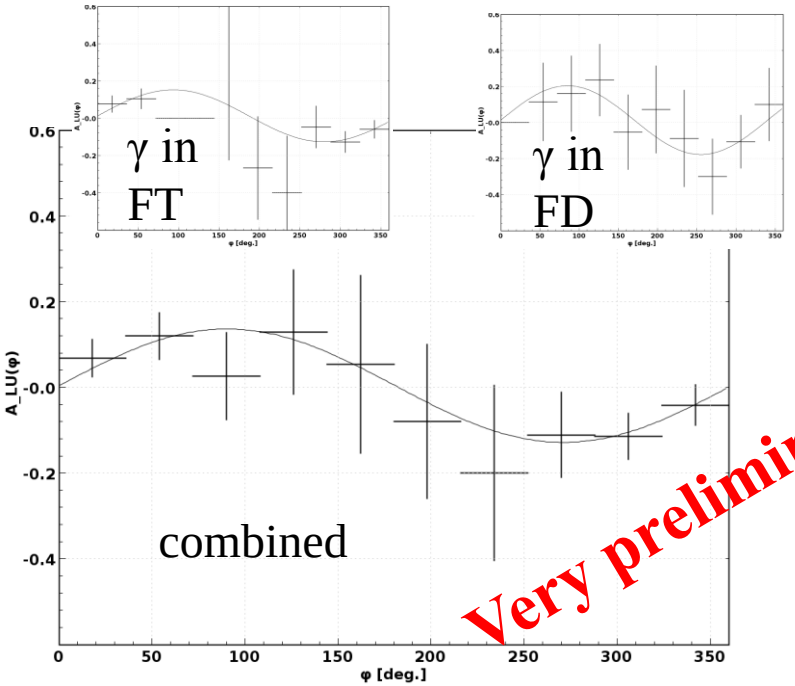








First-time measurement



Conclusions

- RG-B aims at mapping the **3D structure of the neutron** via electroproduction on deuterium
- **Quark-flavor separation** of the measured structure functions combining with proton data
- The first « half » of RG-B running ended on January 30
- **~38.9 PAC days collected out of the 90 PAC days approved for nDVCS**
- Three different beam energies for the 3 periods
- **The Spring dataset has been calibrated and reconstructed** (~50% of the collected statistics)
- **Pass-1 review just passed for the Fall dataset**
- Calibrations well advanced for Winter
- **Jeopardy PAC48 confirmed rating (A, HI) and remaining beam time (51 days)**
- **Physics analyses in good shape**: n/p/d-DVCS, G^n_M, Di-hadron SIDIS, Tagged-DIS, n/p-DVMP(π^0)
- Analysis of K-SIDIS in progress (RG-A being analyzed first)
- nDVCS: work ongoing to refine neutron PID – ***analysis note in preparation***

Back-up slides

Q^2 bins

Projections for nDVCS vs ϕ in 3-dim. bins

[4,inf]

-t bin [0,0.35] GeV²

Data-driven projections for the expected uncertainties, starting from current yield per bin (Y):

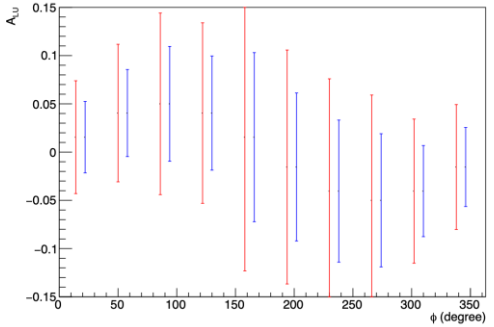
- **expected yield for all existing RGB data (Y*2)**
- **expected yield for 90 PAC days (Y*4)**
- **Assigned $A^{\sin\phi}$=0.05 for all (Q^2, x_B, -t) bins**

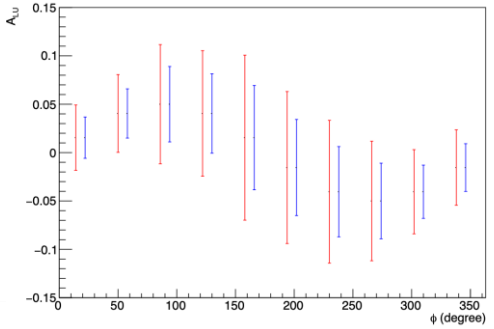
[3,4]

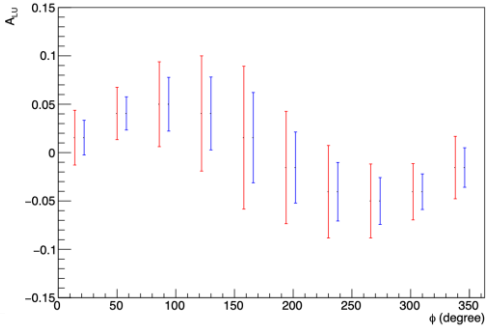
$$\sigma_A = \frac{1}{P_b} \cdot \frac{\sqrt{1 - P_b^2 A^2}}{\sqrt{N}}$$

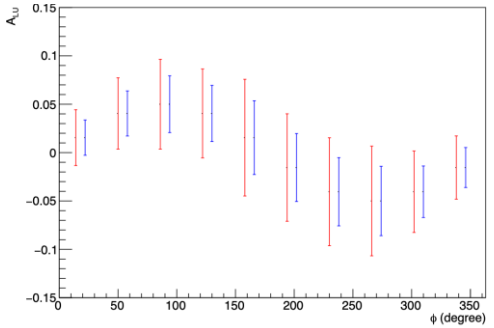
Existing data:
Relative error >100%, worse at high Q^2, low –t, central ϕ → crucial kinematics for GPDs and Ji's sum rule

[2,3]

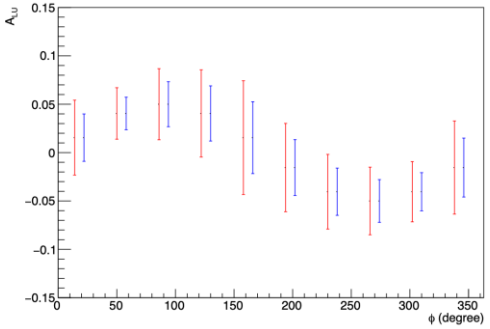


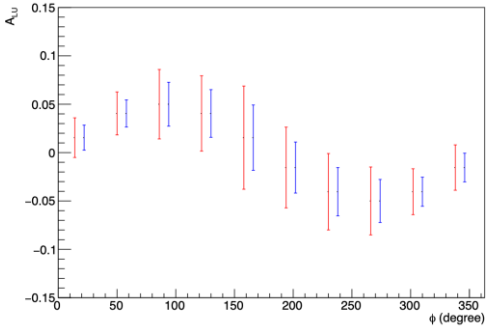


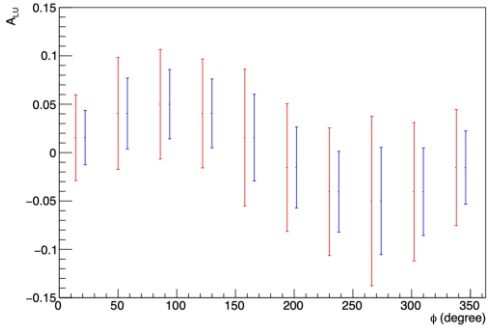




[1,2]







[0.05,0.1] [0.1,0.17] [0.17,inf]

x_B bins

Q^2 bins

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[4,inf]

-t bin [0.35,inf] GeV^2

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[3,4]

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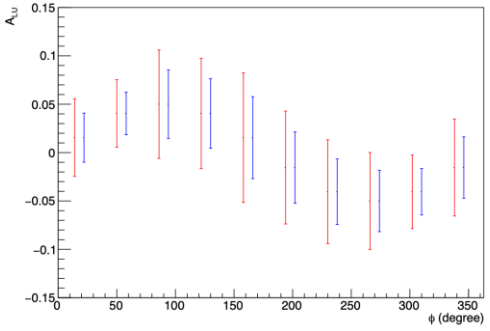
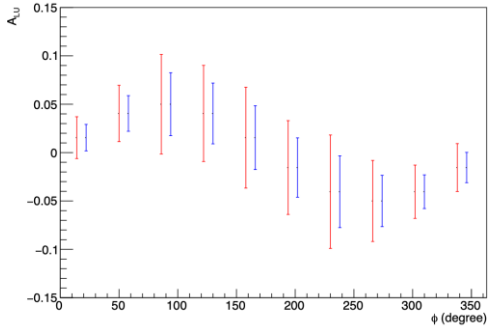
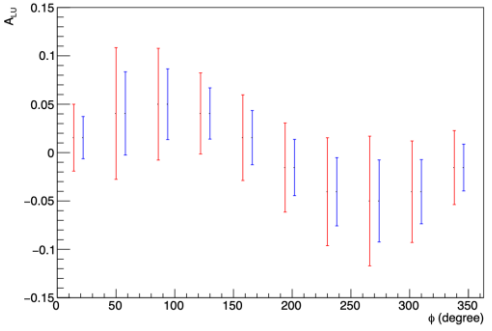
[2,3]







[1,2]

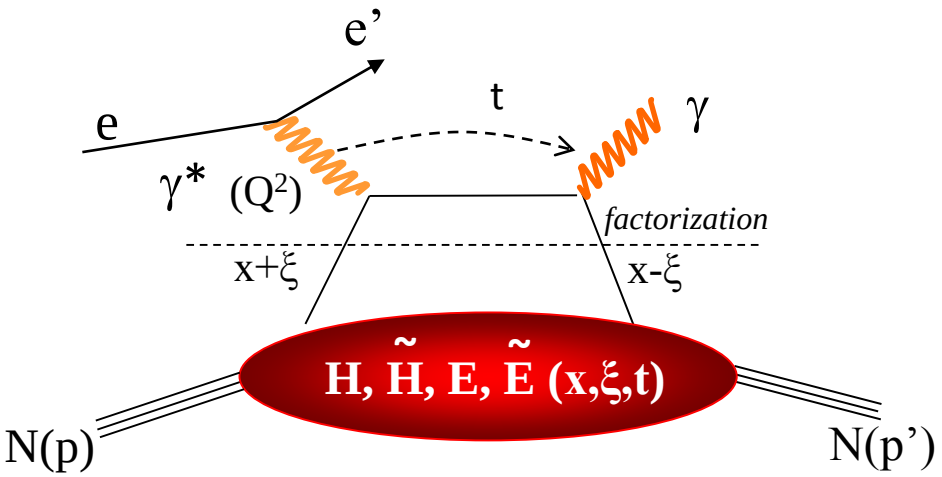
[0.05,0.1]

[0.1,0.17]

[0.17,inf]

x_B bins

Interest of DVCS on the neutron



A combined analysis of DVCS observables for proton and neutron targets is necessary for flavor separation of GPDs

$$(H,E)_u(\xi,\xi,t) = \tfrac{9}{15}\left[4(H,E)_p(\xi,\xi,t) - (H,E)_n(\xi,\xi,t)\right]$$
$$(H,E)_d(\xi,\xi,t) = \tfrac{9}{15}\left[4(H,E)_n(\xi,\xi,t) - (H,E)_p(\xi,\xi,t)\right]$$

$$\frac{1}{2}\int_{-1}^{1} x dx\,(H(x,\xi,t=0) + E(x,\xi,t=0)) = J = \frac{1}{2}\Delta\Sigma + \Delta L$$

The beam-spin asymmetry for nDVCS is the most sensitive observable to the GPD E → Ji's sum rule for Quarks' Angular Momentum

Polarized beam, unpolarized target:

$$\Delta\sigma_{LU} \sim \sin\phi\,\mathrm{Im}\left\{F_1\mathcal{H} + \xi(F_1+F_2)\tilde{\mathcal{H}} + kF_2\mathcal{E}\right\}d\phi \Longrightarrow \mathrm{Im}\{\mathcal{H}_n, \tilde{\mathcal{H}}_n, \mathcal{E}_n\}$$

Unpolarized beam, transversely polarized target:

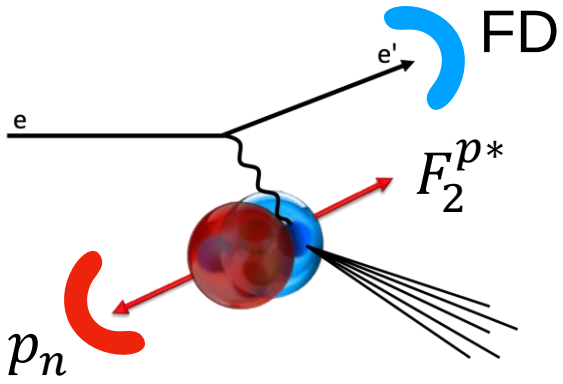
$$\Delta\sigma_{UT} \sim \cos\phi\,\mathrm{Im}\left\{k(F_2\mathcal{H} - F_1\mathcal{E}) + \ldots\right\}d\phi \Longrightarrow \mathrm{Im}\{\mathcal{H}_p, \mathcal{E}_p\}$$

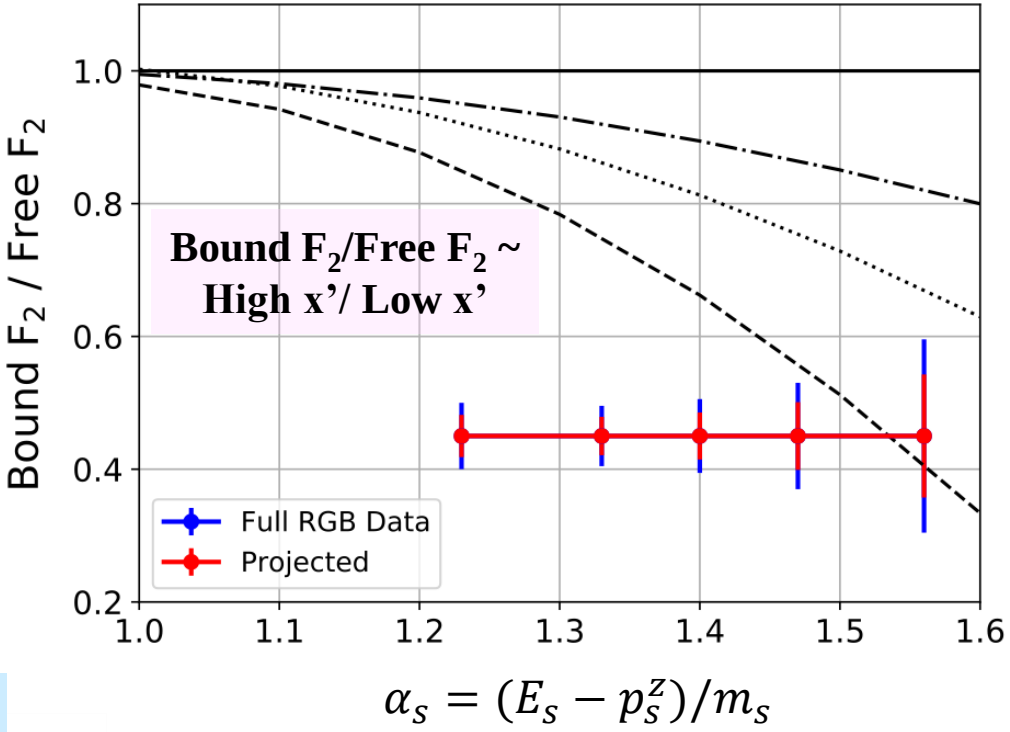
Neutron
Proton

The BSA for nDVCS:

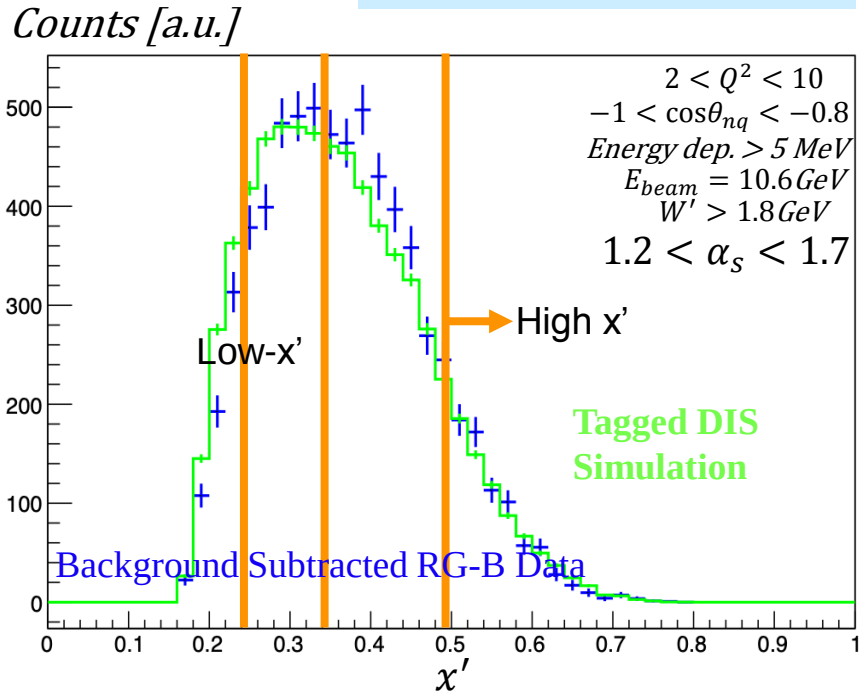
- is complementary to the TSA for pDVCS on **transverse target**, aiming at *E*
- depends strongly on the kinematics → wide coverage needed
- is smaller than for pDVCS → more beam time needed to achieve reasonable statistics

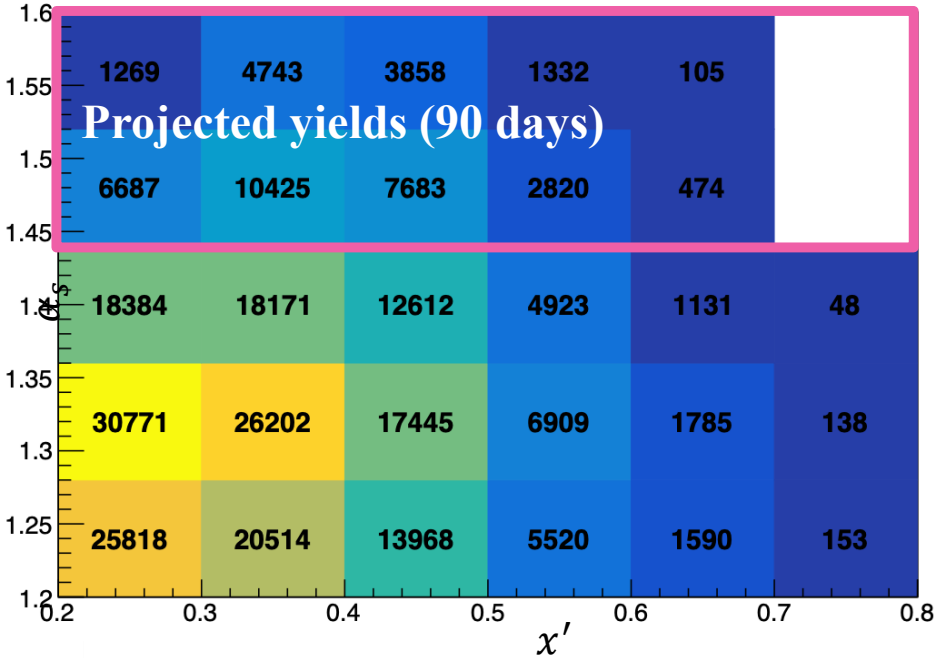
Study bound proton structure by tagging the neutron





E. Segarra et al. (MIT, ODU)

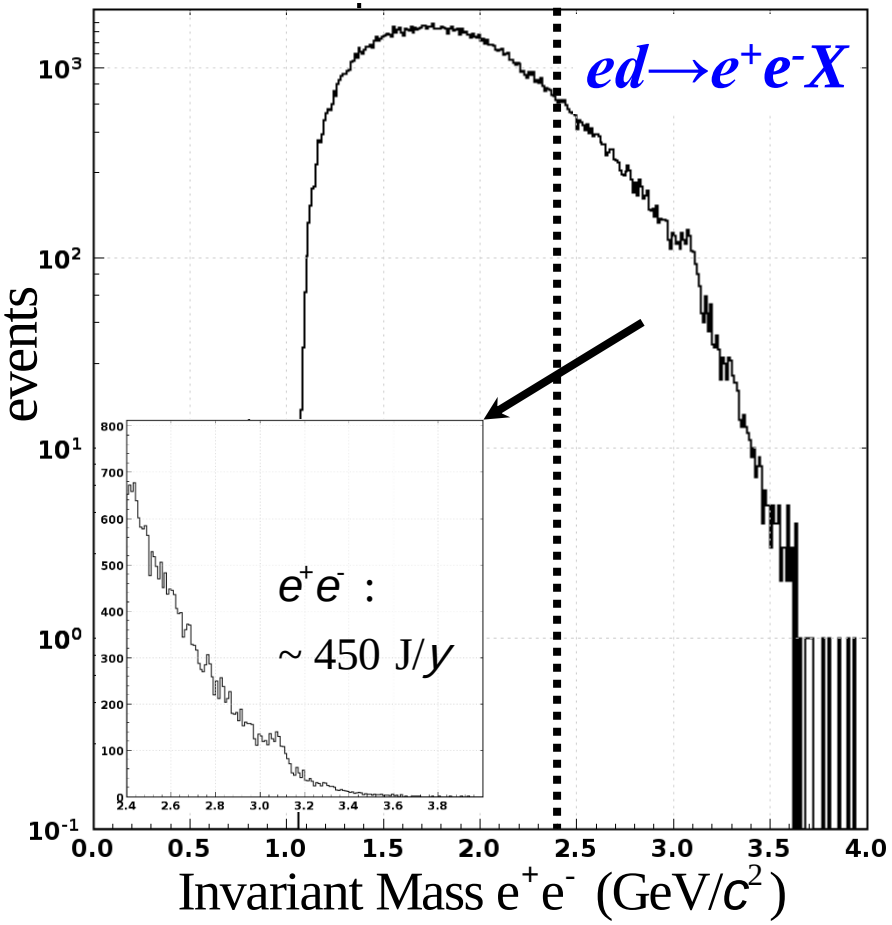




Study of J/ψ Photoproduction off Deuteron

M.D. Baker, A. Freese, L. Guo, Ch. Hyde, **Y. Ilieva**, **B. McKinnon**, **P. Nadel-Turonski**, M. Sargsian, **V. Kubarovsky**, **S. Stepanyan**, N. Zachariou, **Zh.W. Zhao**

All data from Spring 2019



Q1: Impact of experiment remains as high as in 2018 (originally proposed).

• The question about P_C pentaquark signal in photoproduction remains unresolved. Neutron channel is critical given that no positive signal in the proton channel has been reported from Halls D and C.

• This experiment remains the sole near-threshold exclusive study worldwide of re-scattering and coherent physics.

Q2: Data analysis and received data

- Inclusive yield (Spring 2019 data) ~450 J/ψ (e^+e^-). Analysis is in progress for the exclusive channels.
- Pentaquark study: received only 11% of requested 90 days due to energy drop.
- Coherent and incoherent study: received only 22% of requested 90 days due to energy drop.
- **$E_b \geqq 10.6$ GeV is crucial for all of the J/ψ research**.
- The complete data are essential for the extraction of differential cross sections needed to deliver the physics goals of experiment.

Q3: No request for reconsideration of allocated beam time or assigning scientific ranking (remains Run Group Proposal).

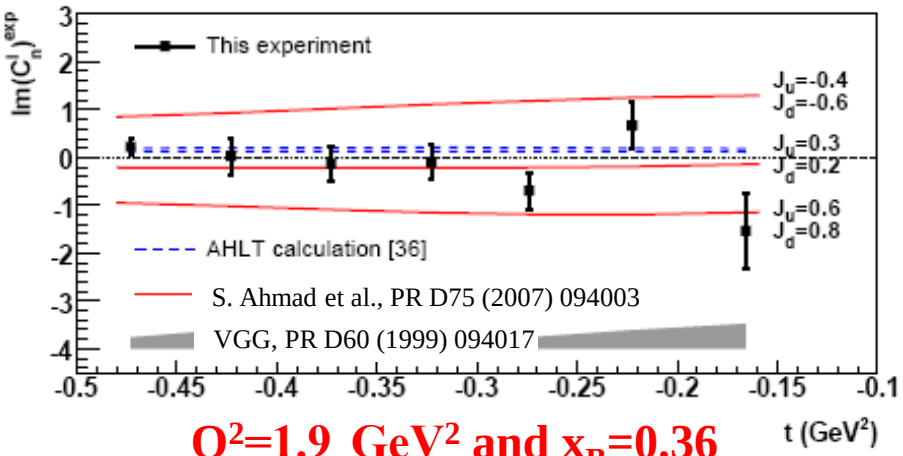
$\vec{e}d \rightarrow e\gamma(np)$

DVCS on the neutron in Hall A at 6 GeV

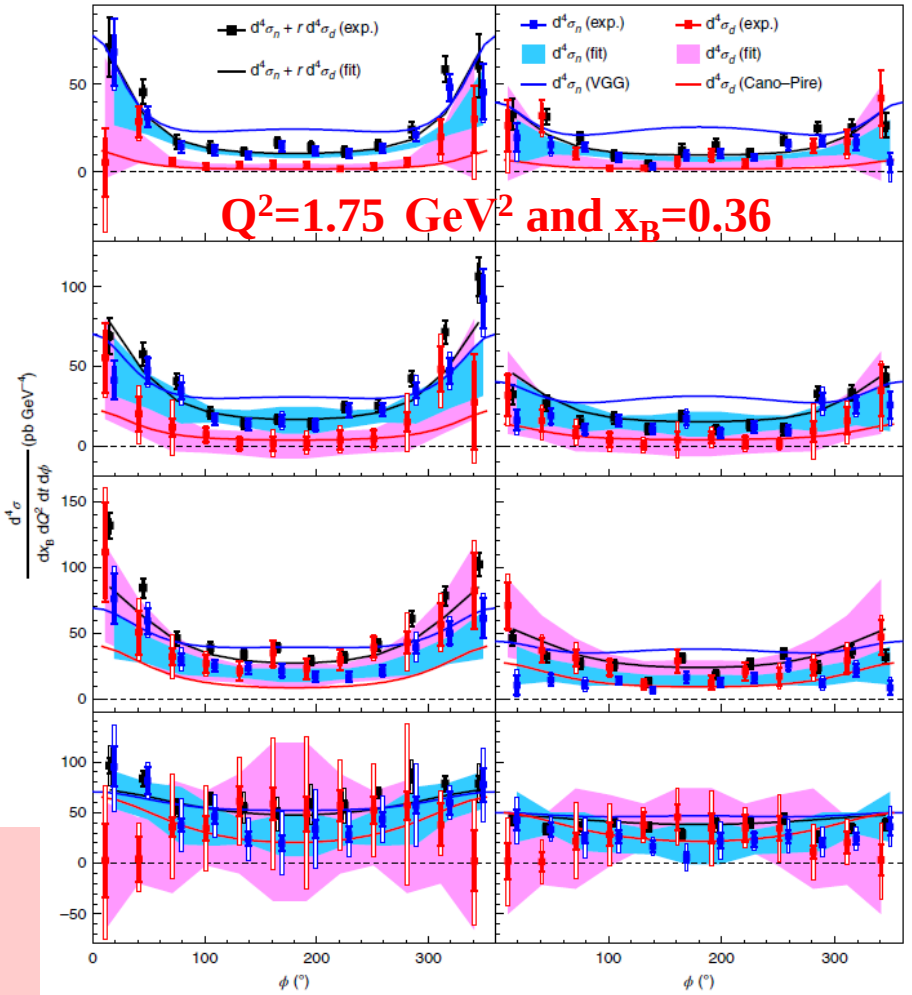
$$D(e,e'\gamma)X - H(e,e'\gamma)X = n(e,e'\gamma)n + d(e,e'\gamma)d + \ldots$$

$$\Delta\sigma_{LU} \sim \sin\phi\ \mathbf{Im}\{F_1\mathcal{H} + \xi(F_1+F_2)\widetilde{\mathcal{H}} - kF_2\mathcal{E}\}$$

M. Mazouz et al., PRL 99 (2007) 242501



Q^2=1.9 GeV^2 and x_B=0.36



Q^2=1.75 GeV^2 and x_B=0.36

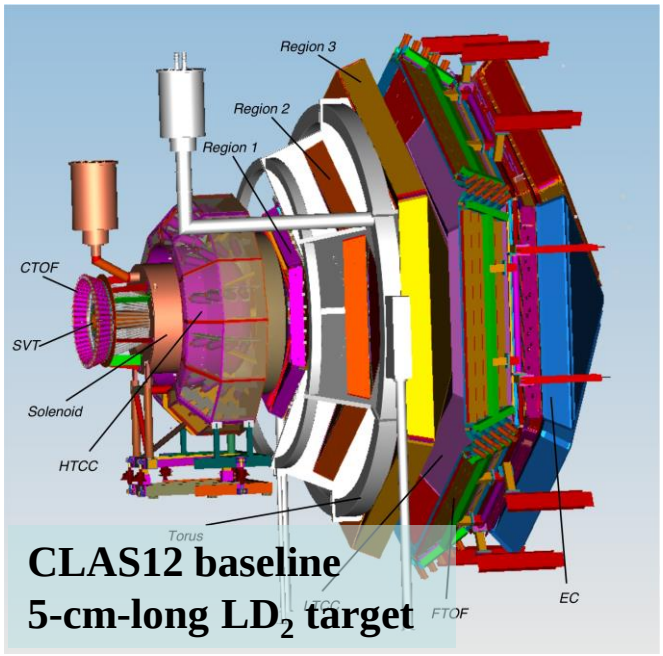
- E03-106: First-time measurement of $\Delta\sigma_{LU}$ for nDVCS, ***no neutron detection***
- model-dependent extraction of J_u, J_d

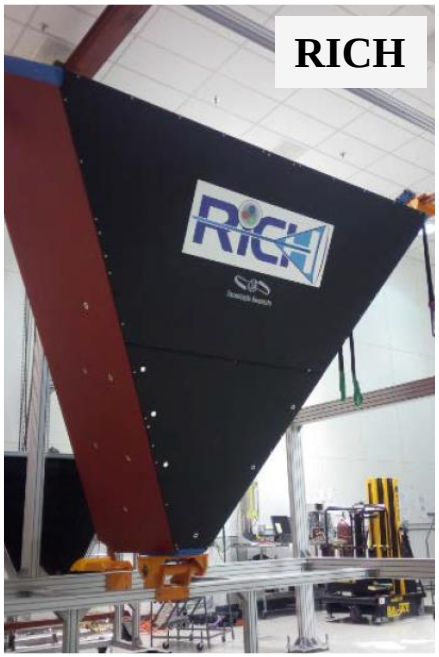
These pioneering results underline the importance of nDVCS for GPD physics, and point to the need for a dedicated nDVCS experiment with neutron detection and wide coverage

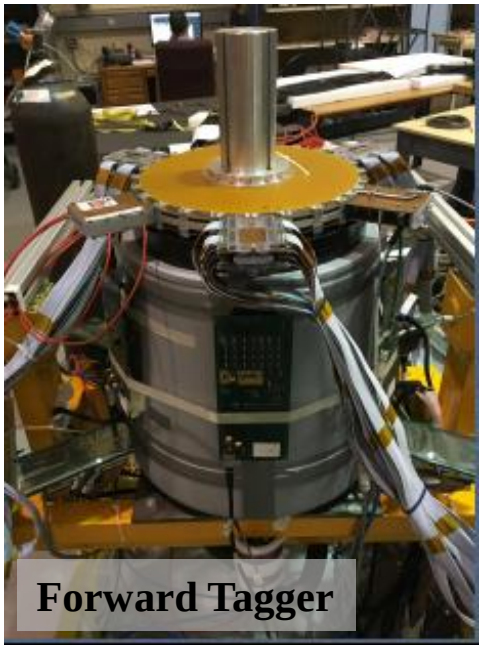
Hall-A experiment E08-025 (2010)

- Beam-energy « Rosenbluth » separation of nDVCS/BH CS using two beam energies
- First observation of non-zero nDVCS CS
- **M. Benali et al., Nature 16 (2020)**

Experimental setup

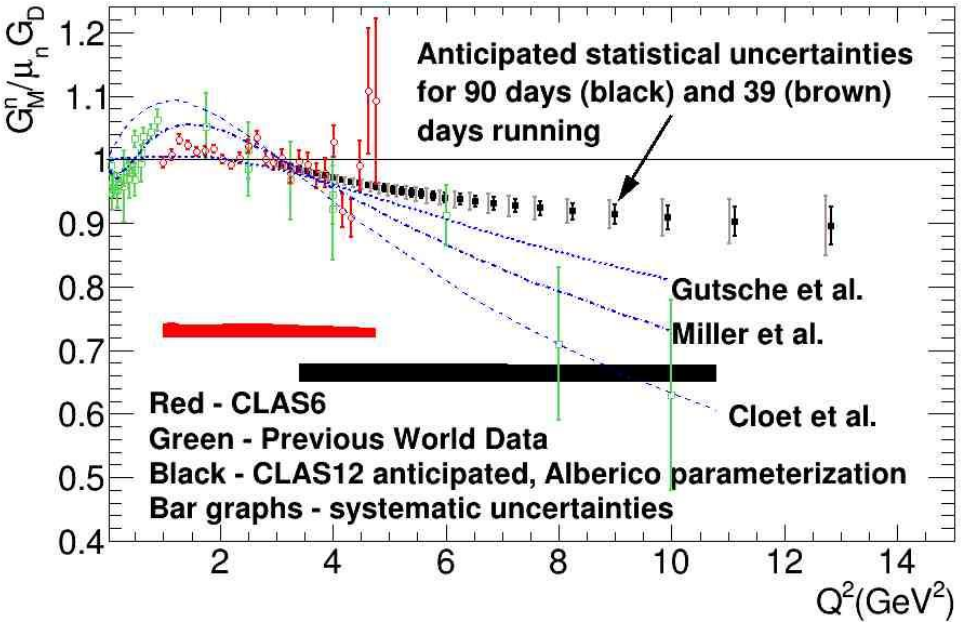






Measurement of the Neutron Magnetic Form Factor G_M^n at High Q^2 Using the Ratio Method on Deuterium

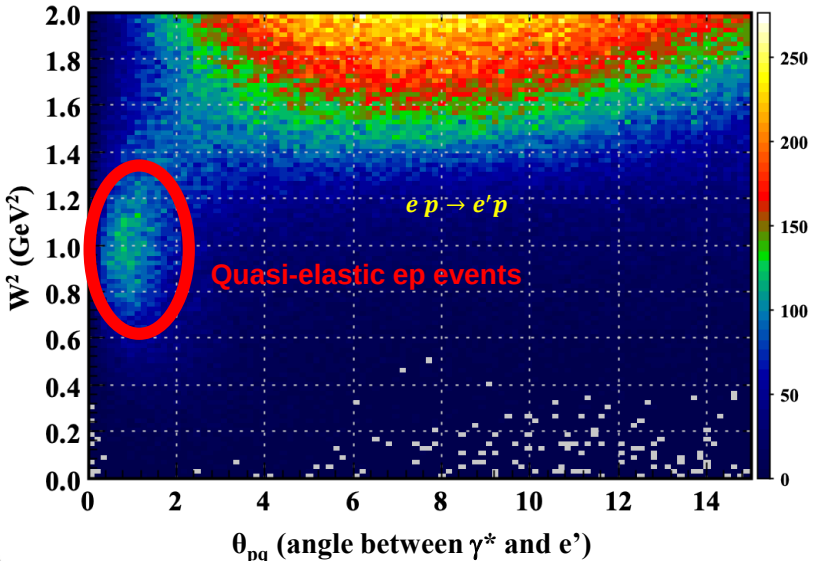
Goal: Extract G_M^n at high Q^2 using the ratio of quasi-elastic e-n and quasi-elastic e-p on deuteron: $R = \frac{d(e,e'n)p}{d(e,e'p)n}$

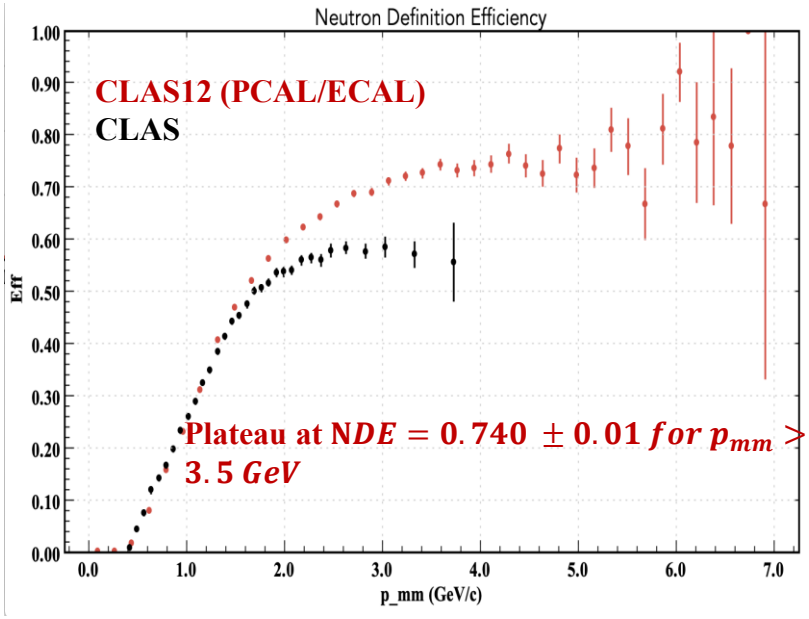


90-days RG-B run time will extend the reach in Q^2 where no data exist with high statistical precision

Analysis status:

- Using **RG-B** data from spring 2019 to extract **quasi-elastic ep and en events**
- Using **RG-A** data from fall 2018 to measure **neutron detection efficiency** with the **ep→eπ⁺n** channel





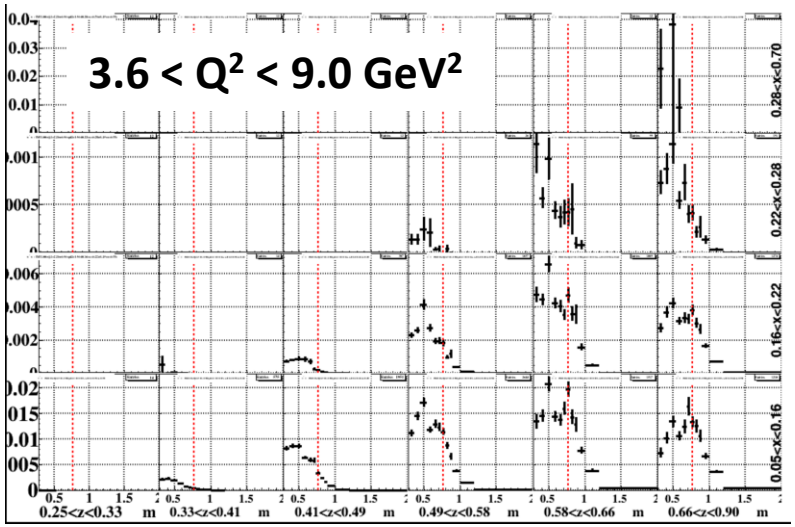
L.Baashen, B. Raue (FIU), G. Gilfoyle (U. Rich.), L.C. Smith (UVA)

SIDIS di-hadron will full statistics

Completion of the run will provide about x5 more statistics than the one showed in the plots, allowing:

- **improved sensitivity in the high x and high Q2 region**
- **better precision in extracting D_1^d**
- **access to TMD adding p_T dependence (5D analysis)**

deuteron mutiplicities



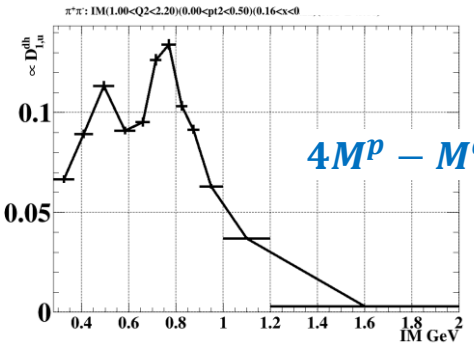
$0.28<x_B<0.70$

$0.22<x_B<0.28$

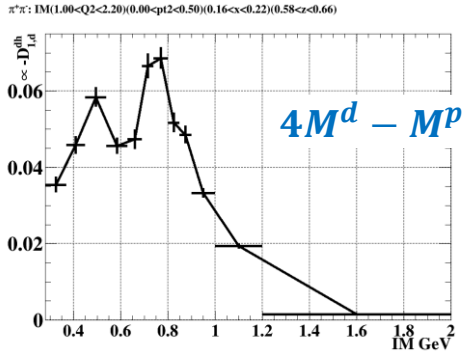
$0.16<x_B<0.22$

$0.05<x_B<0.16$

$1 < Q^2 < 2.2$ GeV²



0.16< x <0.22
0.58< z <0.66




```
RGA: pi+pi-/pi+: 0.067,  pi+pi-/pi-: 0.196
RGB: pi+pi-/pi+: 0.073,  pi+pi-/pi-: 0.167
```

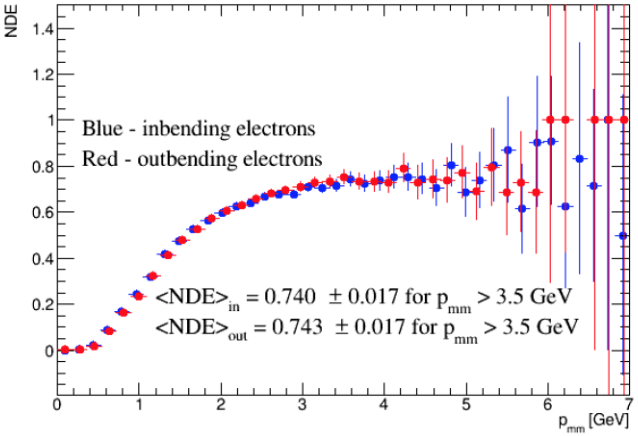
Measuring the neutron detection efficiency (NDE) needed for quasi-elastic e-n $e\,D \rightarrow e'\,n\,(p)$

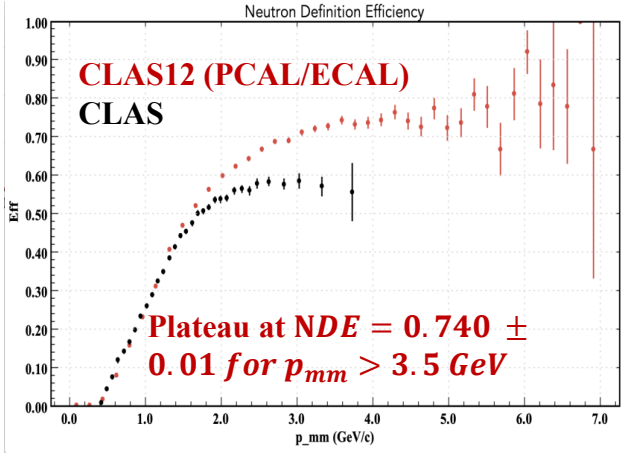
Analysis status:

- Using RG-A data from fall 2018 (pass 1 cooking) ~ 359 runs
- Use $ep \rightarrow e'\pi^{+}(n)$ as a source of tagged neutrons in the calorimeter
- NDE ~ 0.74 at the plateau (p_{mm} > 3.5 GeV) for outbending and inbending electrons
- CLAS12 measurement reaches higher efficiency thanks to PCAL.

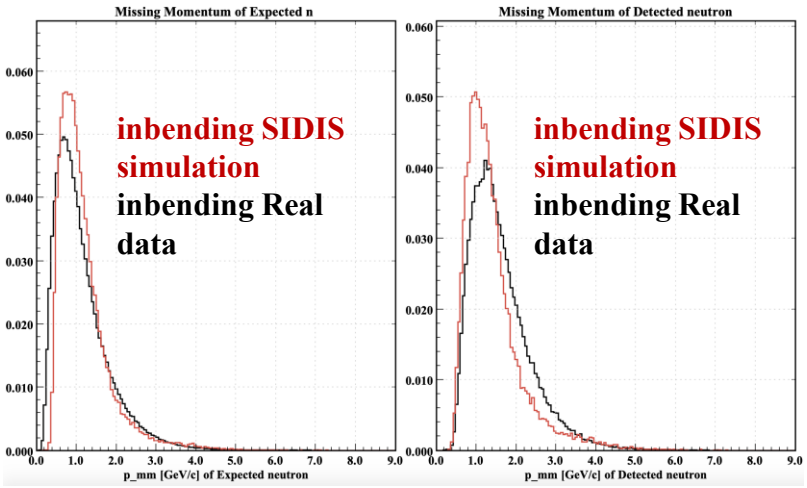
Next steps:

Investigating the accuracy of both the numerator and denominator of the efficiency ratio to determine the shape of the background in simulation.





Simulate events using SIDIS and A0/MAID2000 event generators. Preliminary comparison with data from the SIDIS simulation is shown here.

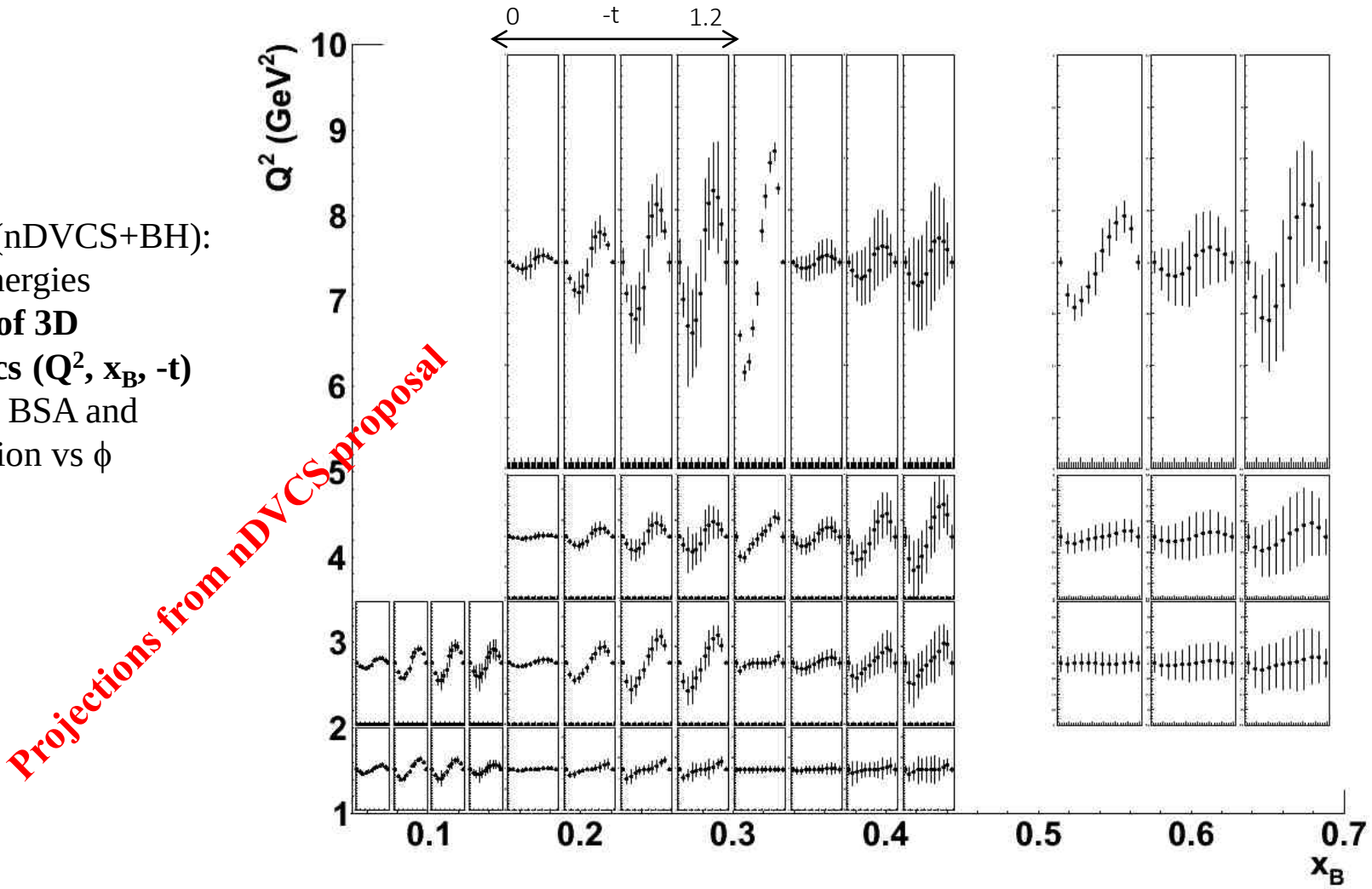


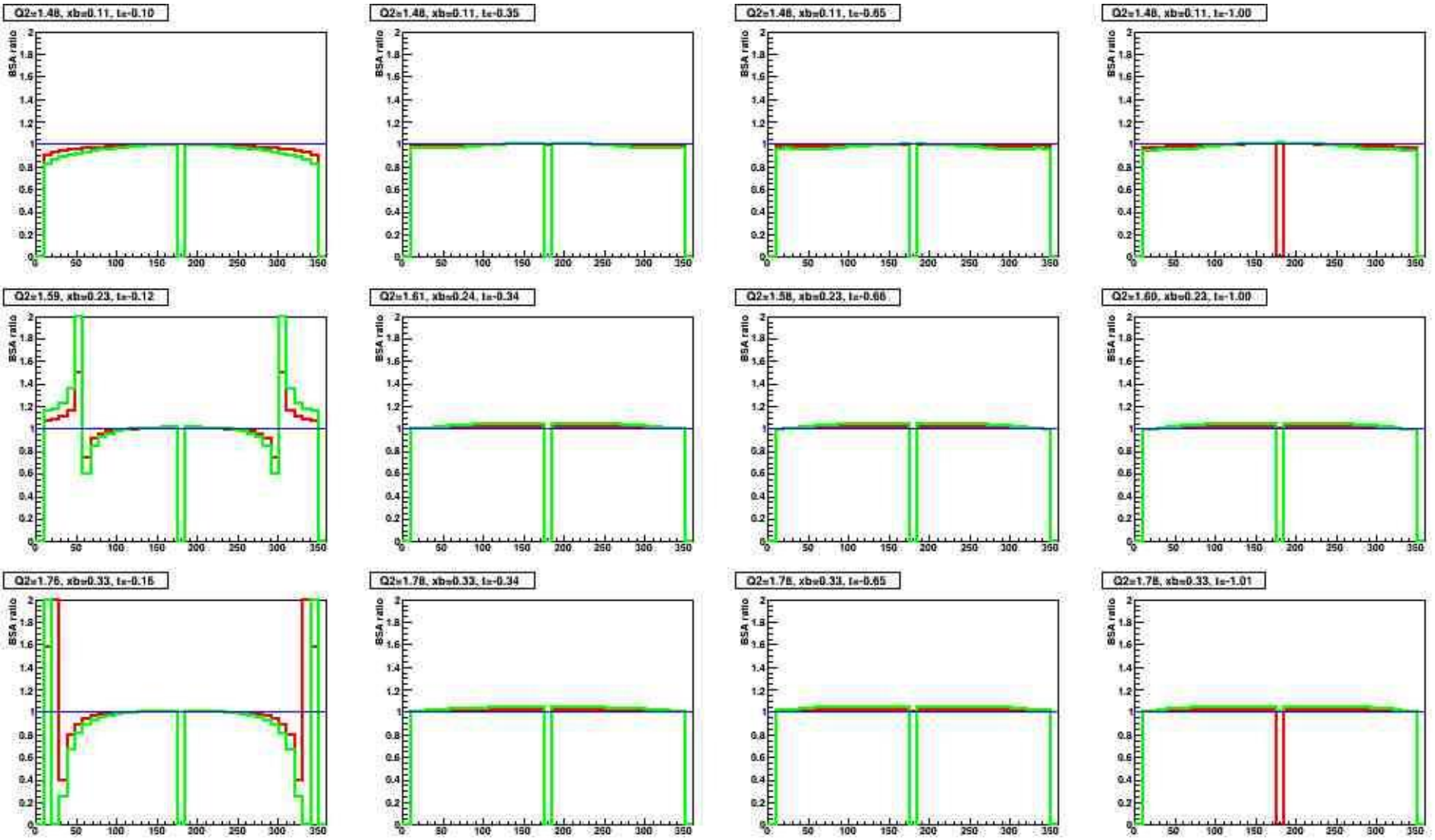
Measurement of BSA for nDVCS-BH with 3 different beam energies

RG-B ran at 3 different beam energies: 10.6 GeV, 10.2 GeV, 10.4 GeV
Can we combine (and how?) the BSA extracted from the 3 sets?

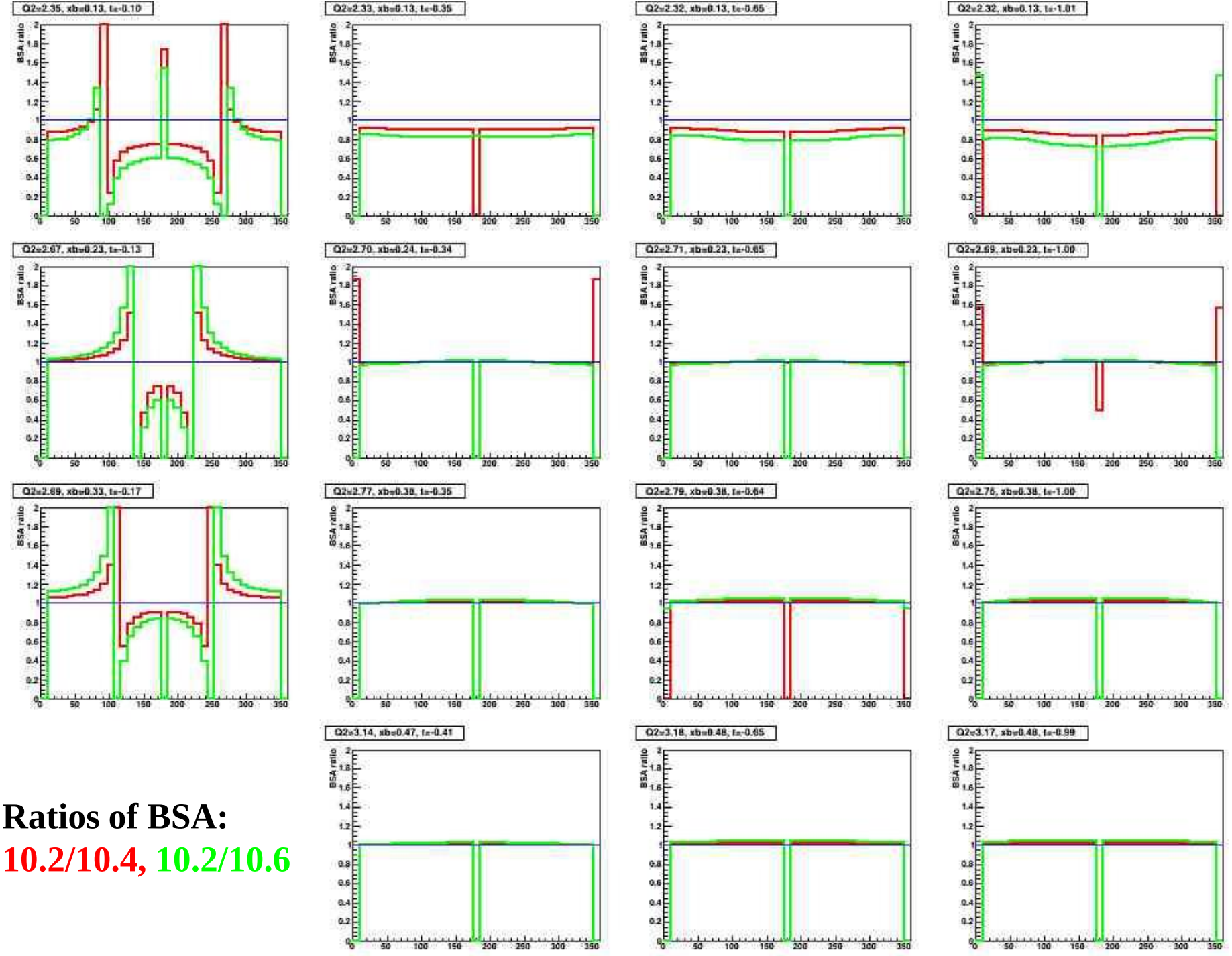
VGG model (nDVCS+BH):

- 3 beam energies
- **same set of 3D kinematics (Q^2, x_B, -t)**
- computed BSA and cross section vs ϕ





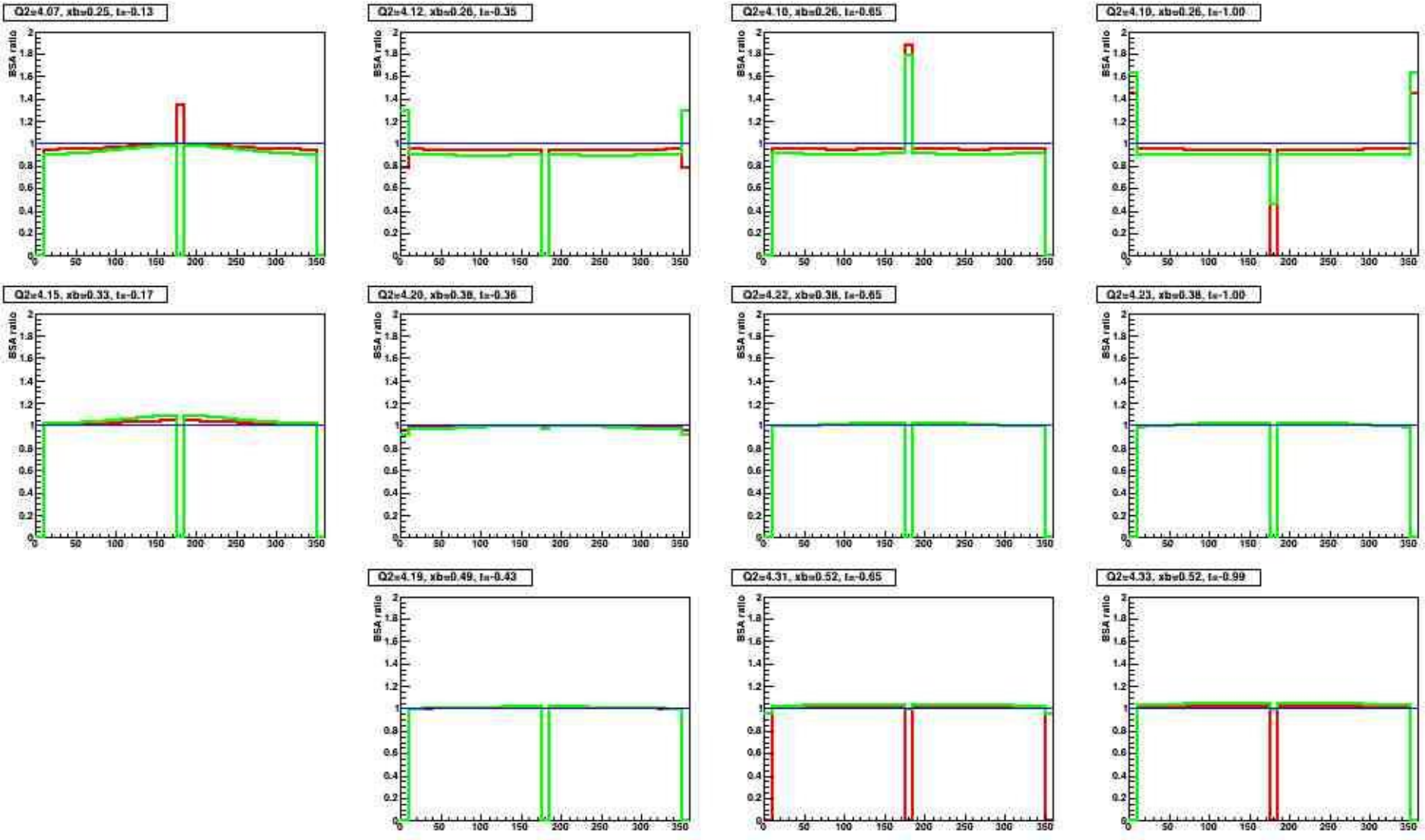
Ratios of BSA: 10.2/10.4, 10.2/10.6



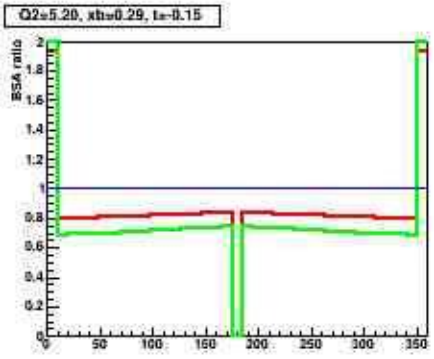
Ratios of BSA:

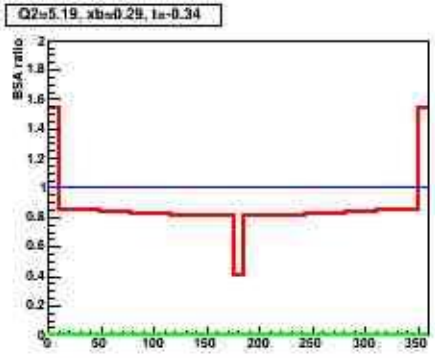
10.2/10.4, 10.2/10.6

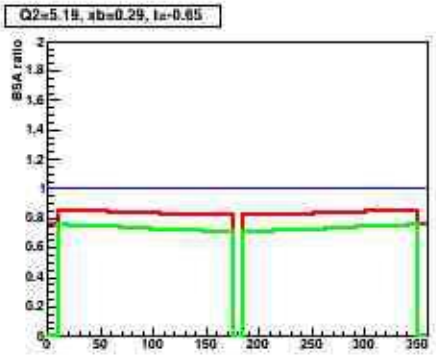
Ratios of BSA: 10.2/10.4, 10.2/10.6

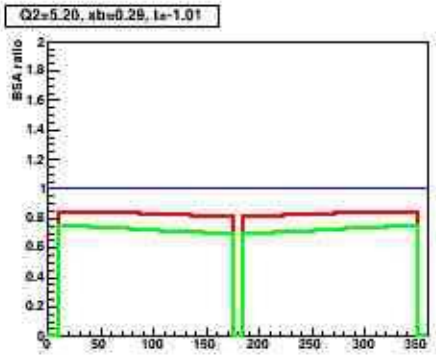


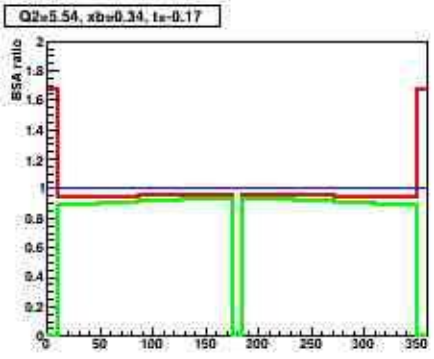
Ratios of BSA: 10.2/10.4, 10.2/10.6

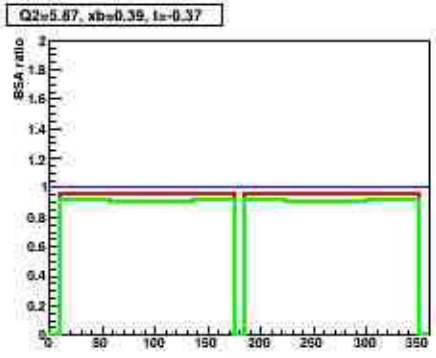


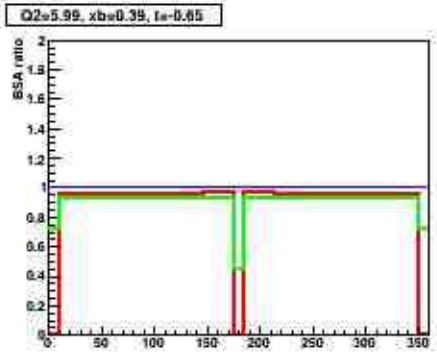


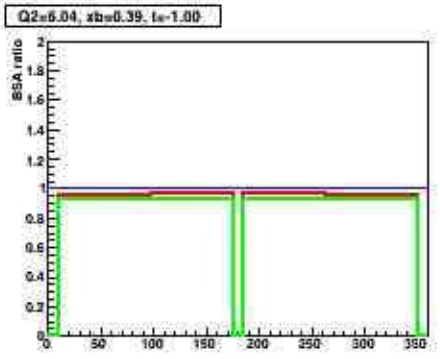


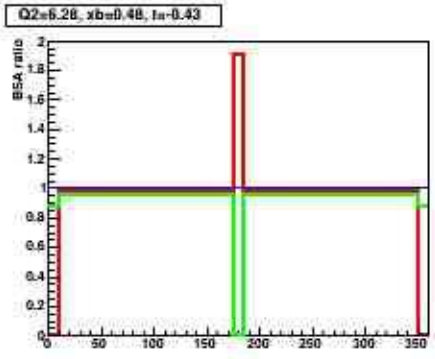


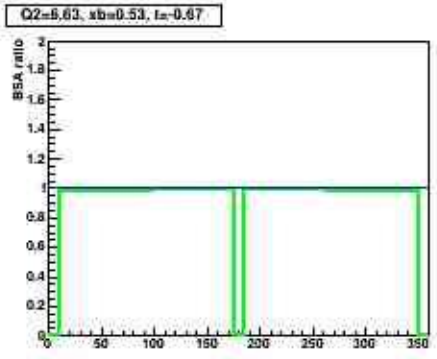


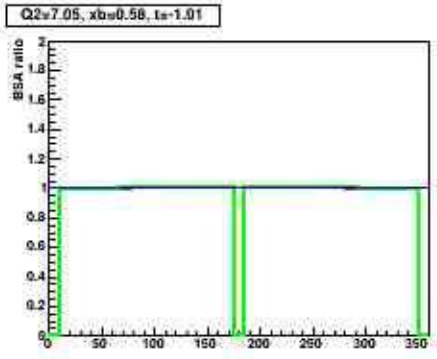


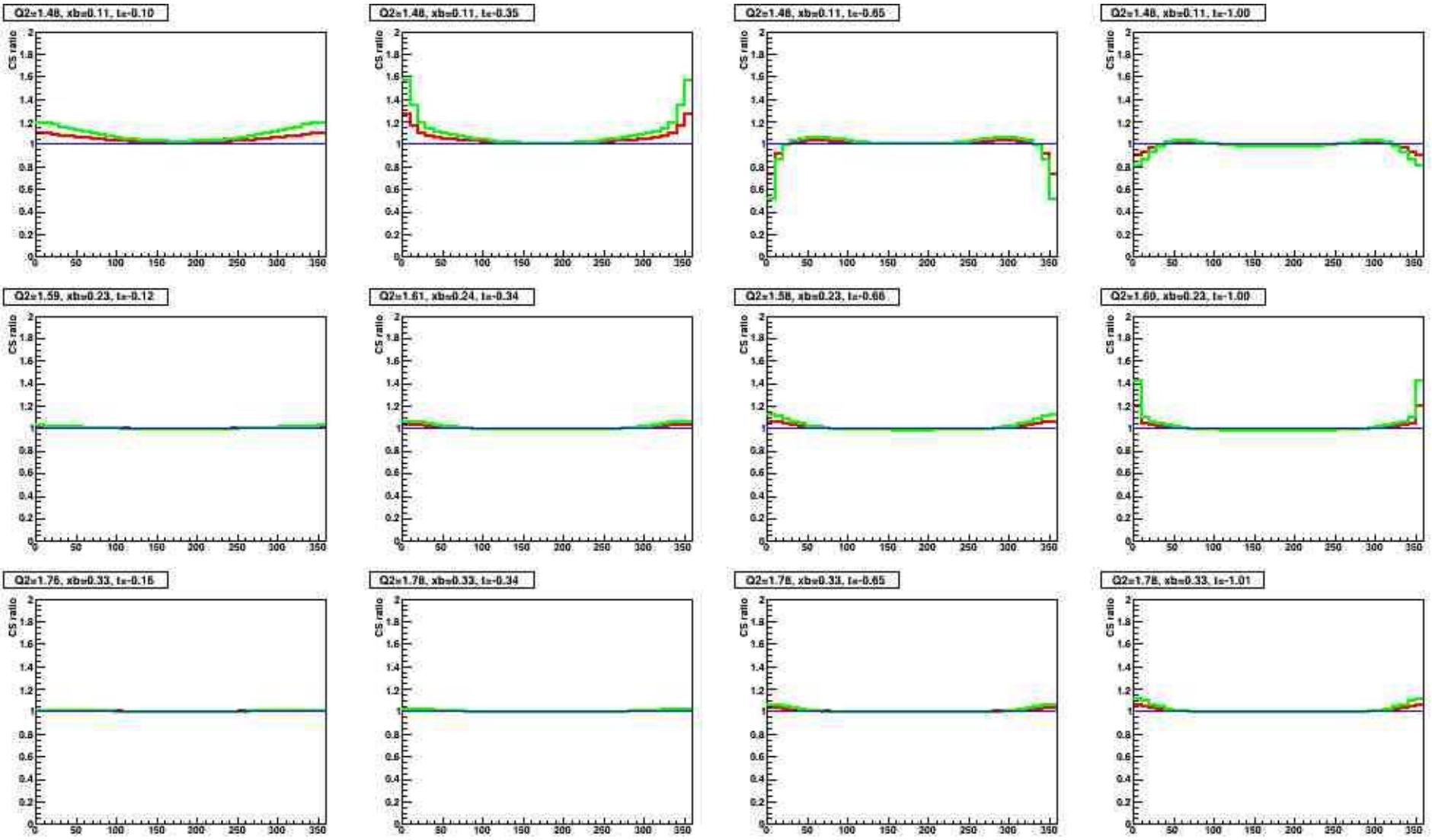




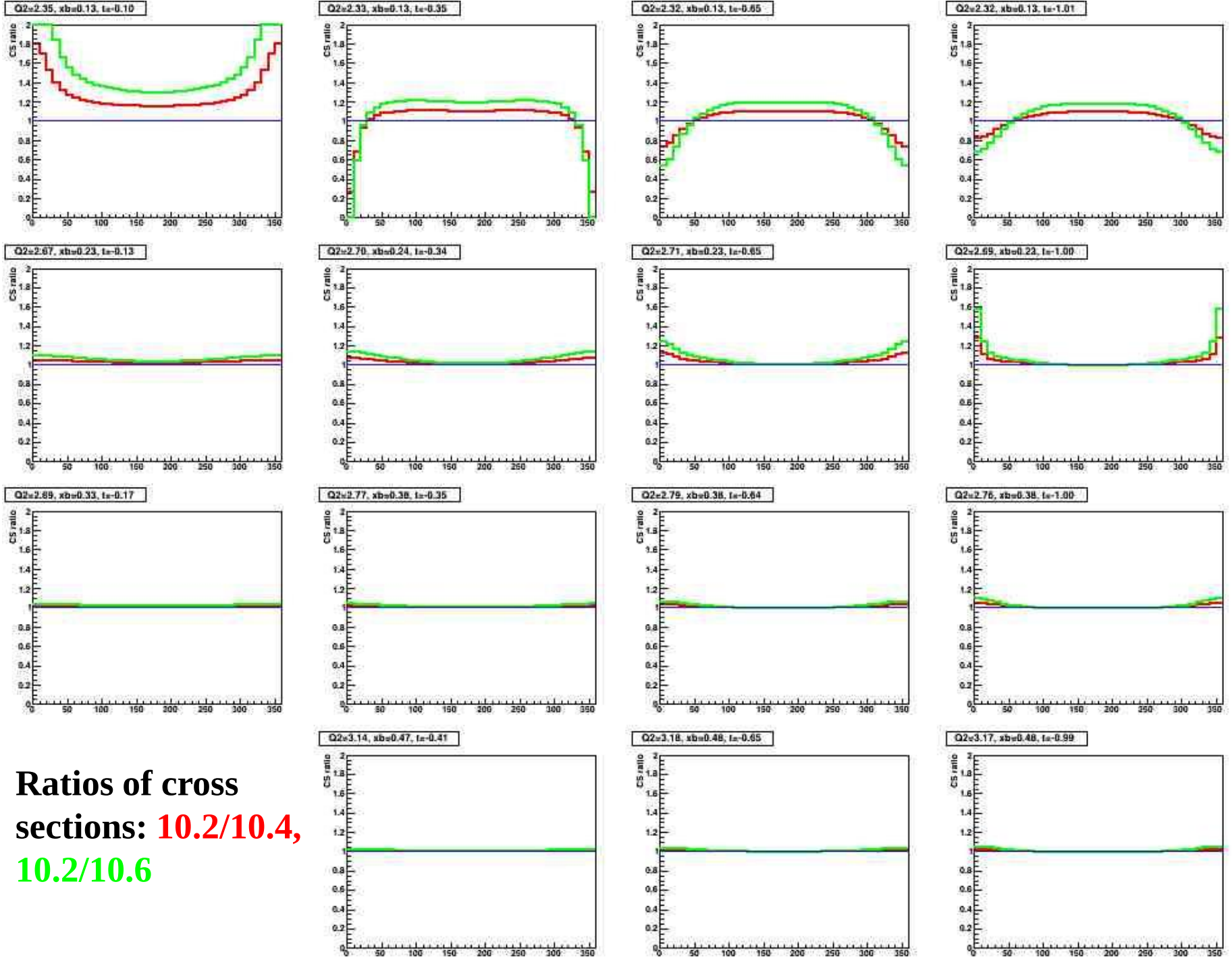








Ratios of cross sections: 10.2/10.4, 10.2/10.6



Ratios of cross sections: 10.2/10.4, 10.2/10.6

Conclusions on beam-energies impact on nDVCS

- The BSA is less sensitive than the absolute cross section to the variations of beam energy
- Depending on the kinematics, the BSA varies from a % to 20-30% (especially for 10.2-10.6)
- Strong variations of the CS impact the definition of the central kinematics of each bin
- The edges in ϕ are the most affected (that's where BH dominates), but at the highest Q^2 the effect is over all ϕ
- It will need to be restudied with a more realistic grid of bins
- Definition of central kinematics of the bins quite crucial and not trivial

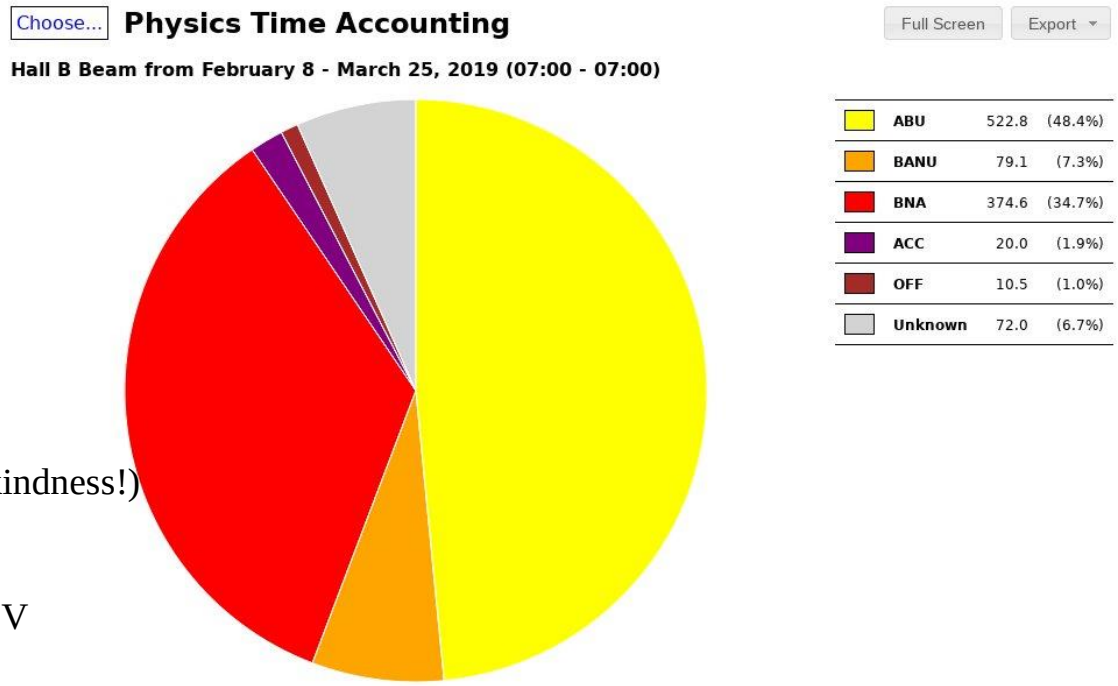
Run Group B spring 2019 run

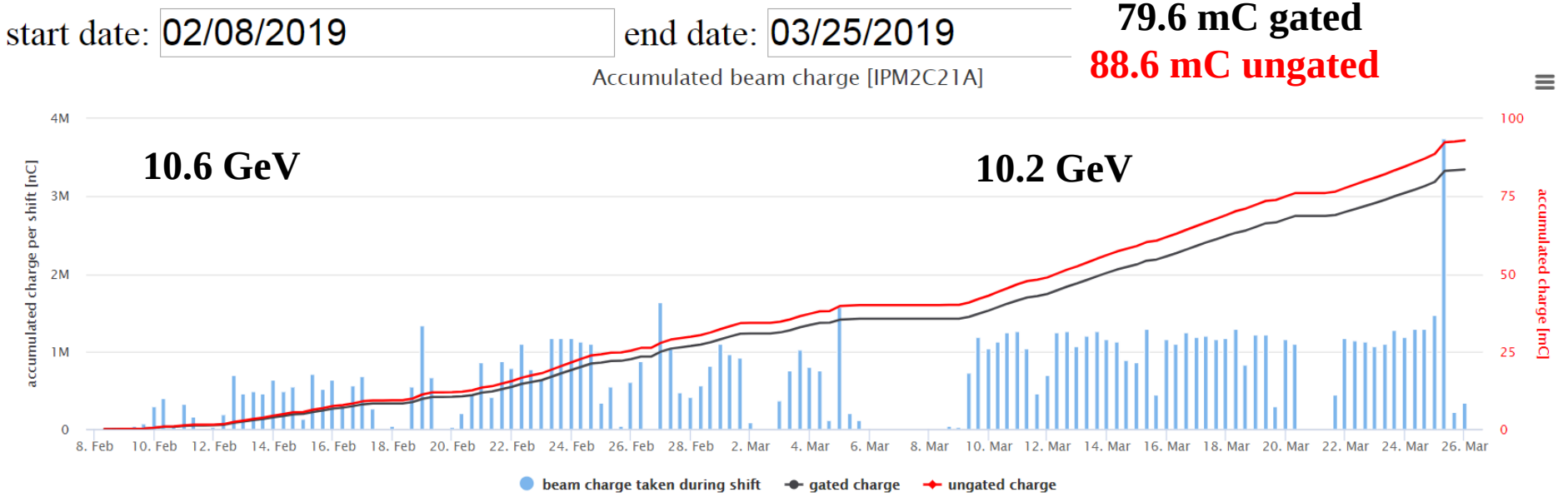
Running conditions:

- **10.6** – **10.2** GeV beam energy
- Torus ***inbending***
- Production current: 35 nA → 50 nA
- Event-weighed average current: 47.9 nA
- DAQ rate: ~14 kHz

Outcome:

- Original schedule: 1/30 – 3/10
- Final accelerator schedule: 2/8 – 3/17
- Actual days ran: 2/8 – 3/25 (thanks to RG-A's kindness!)
- 21.7 PAC days according to ABUs (48.4%)
- 237 good production runs
- ~9.7 B triggers at 10.6 GeV, ~11.7 B at 10.2 GeV





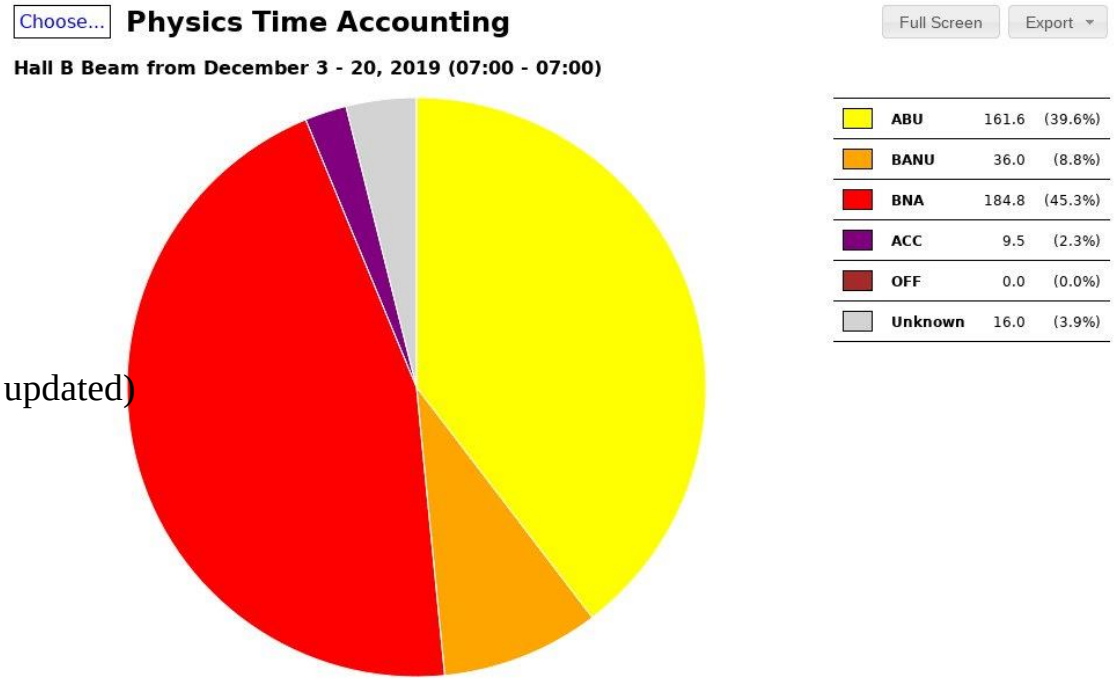
Run Group B fall 2019 run

Running conditions:

- **10.4** GeV beam energy
- Torus ***outbending***
- Production current: 40 nA
- Event-weighed average current: 38.8 nA
- DAQ rate: ~24 kHz
- ~1 day at 2-pass for BAND

Outcome:

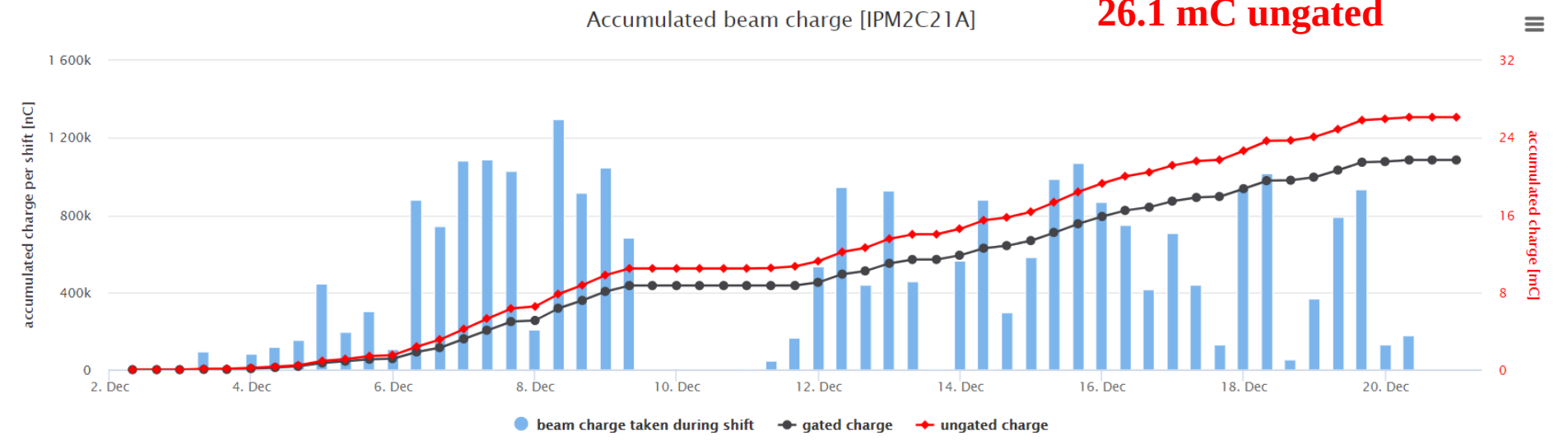
- Accelerator schedule: 11/25 – 12/19 (should be updated)
- Actual days ran: 12/3 – 12/20
- 6.7 PAC days according to ABUs (39.6%)
- 91 good production runs
- ~9. B triggers at 10.4 GeV



start date: 12/02/2019 end date: 12/20/2019

21.7 mC gated

26.1 mC ungated



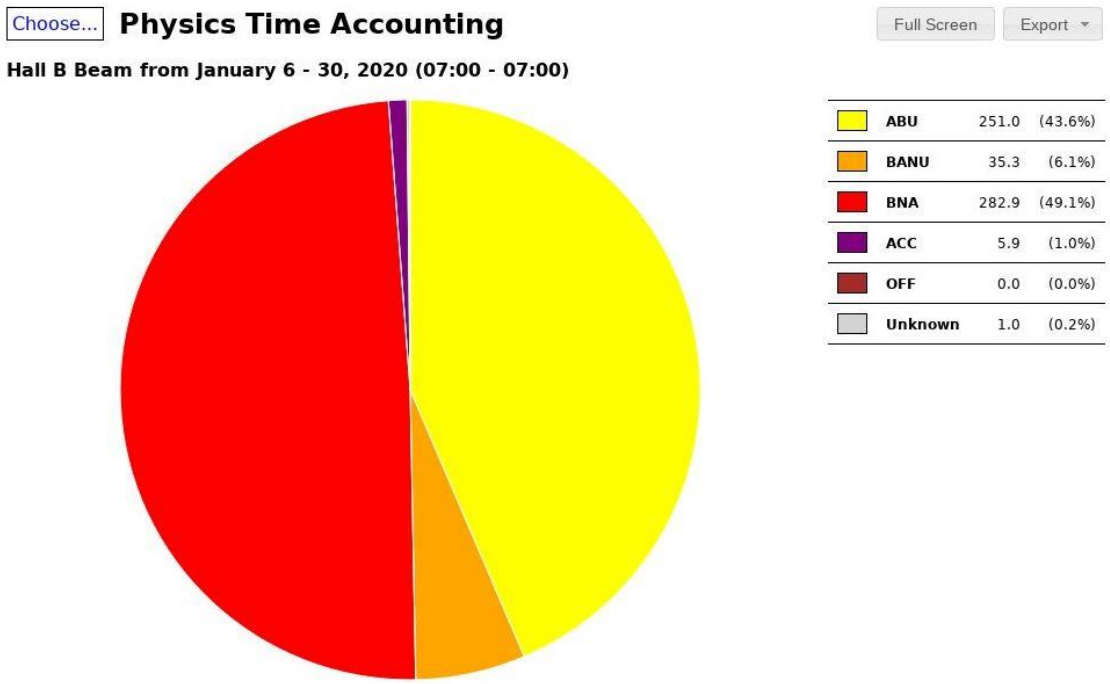
Run Group B winter 2020 run

Running conditions:

- **10.4** GeV beam energy
- Torus ***inbending***
- Production current: 40 → 50 nA
- Event-weighed average current: 45.1 nA
- DAQ rate: ~19 kHz

Outcome:

- Accelerator schedule: 1/10 – 1/29
- Actual days ran: 1/7 – 1/29
- 10.5 PAC days according to ABUs (43.6%)
- 181 good production runs
- 12.9 B triggers at 10.4 GeV



start date: 01/05/2020 end date: 01/30/2020

35.2 mC gated

39.9 mC ungated