CLAS12 Run Group B

Electroproduction on deuterium with CLAS12

- Physics goals
- RG-B experiments
- Overview of the data taking
- Analysis updates and preliminary results
- Beam time request

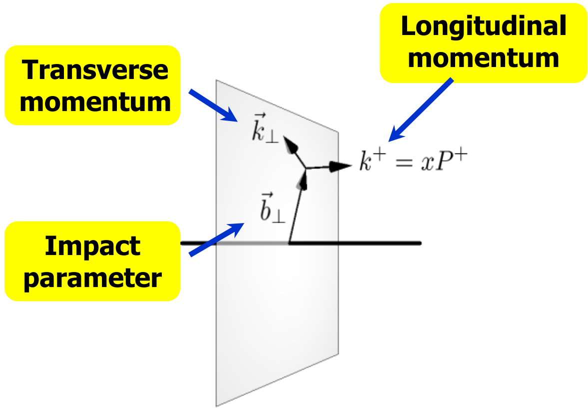
1) Is there any ***new information*** *that would affect the scientific importance or impact of the experiment since it was originally proposed?*
2) If the experiment has already received a portion of its allocated beam time and/or is on the presently published accelerator schedule, the spokespersons should provide an ***analysis of the existing data set****, the* ***projected result*** *for any additional time on the published schedule, and the projected result for the complete data set including all remaining unscheduled time. The goal is to show the* ***physics impact*** *of the respective data sets.*
3) Should the remaining beam time allocation and experiment grade be reconsidered?

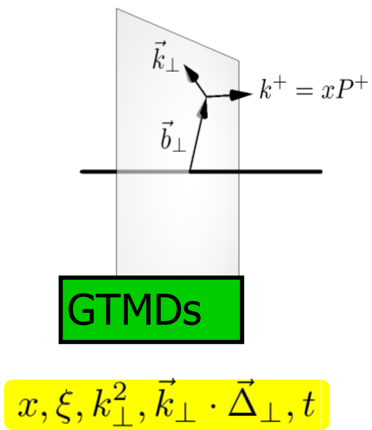
Silvia Niccolai, IJCLab Orsay
PAC48, 9/25/2020

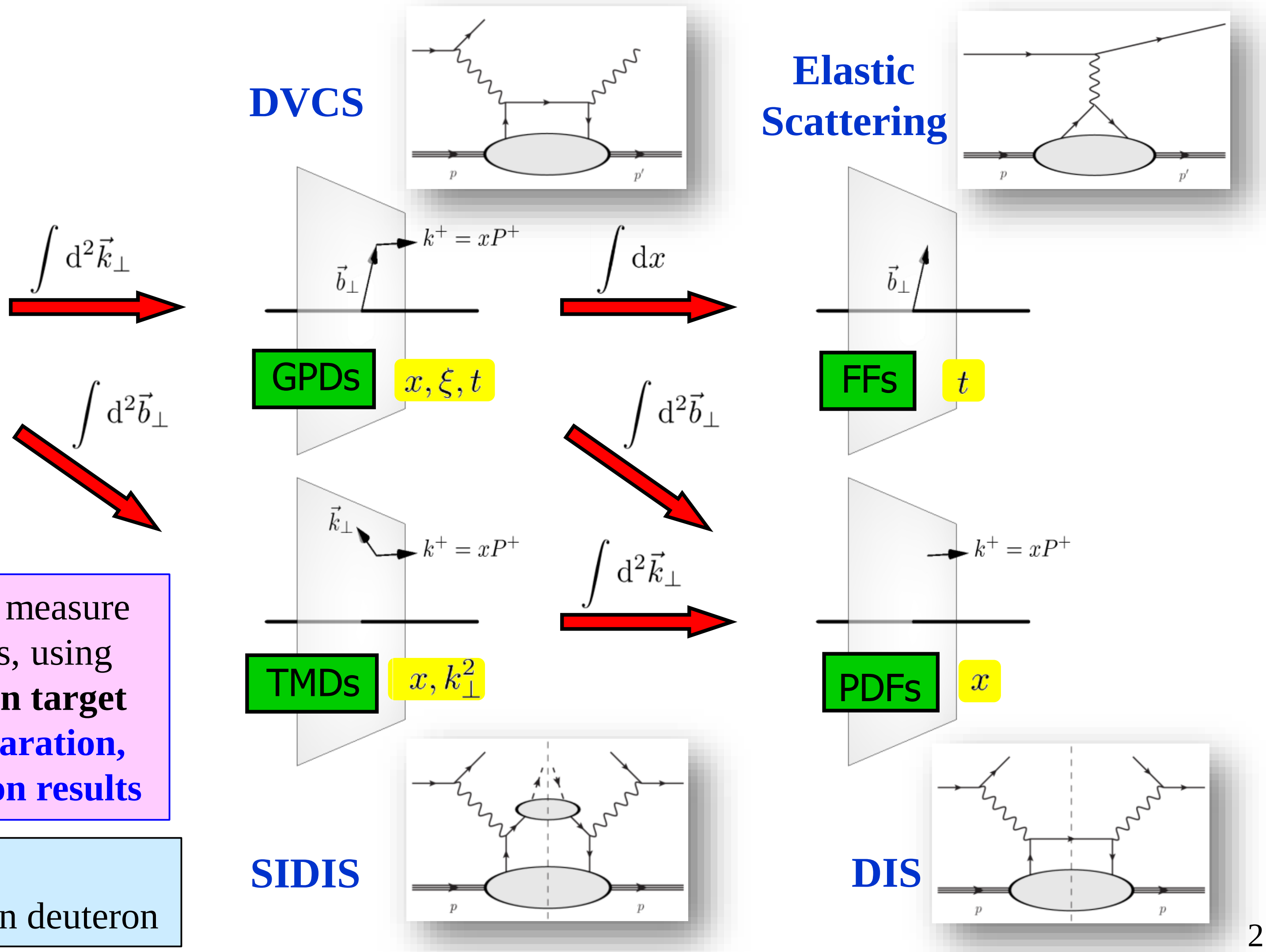
IJCLab Irène Joliot-Curie
Laboratoire de Physique des 2 Infinis

Multi-dimensional mapping of the nucleon

A complete picture of nucleon structure requires the **measurement of all these distributions**.



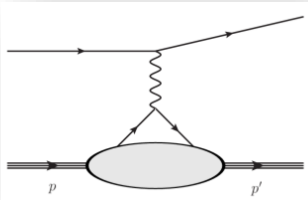




Run-Group B aims to measure all these distributions, using **deuteron** as a **neutron target**
→ Quark-flavor separation, combining with proton results

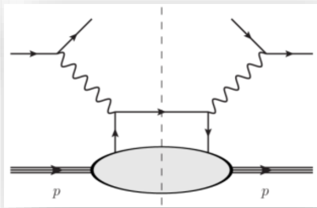
+ EMC effect, SRC
+ J/ψ photoproduction on deuteron

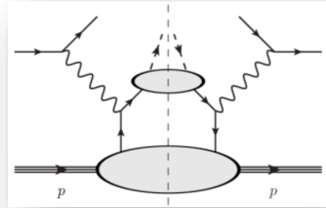
CLAS12 Run Group B: experiments



Elastic Scattering (G^n_M)

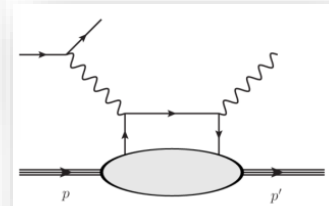
DIS (for SRC and EMC effect)

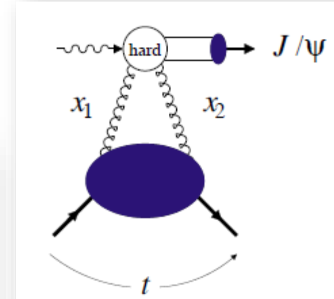




SIDIS (for PDFs and TMDs

nDVCS





J/ψ photoproduction

E12-07-104	Neutron magnetic form factor	G. Gilfoyle	A- 30
E12-09-007a	Study of parton distributions in K SIDIS	W. Armstrong	A- 56
E12-09-008	Boer-Mulders asymmetry in K SIDIS	M. Contalbrigo	A- 56
E12-11-003	Deeply virtual Compton scattering on the neutron	S. Niccolai	A **(HI) 90**
E12-09-008b	Collinear nucleon structure at twist-3 in di-hadron SIDIS	M. Mirazita	RG
E12-11-003a	In medium structure functions, SRC, and the EMC effect	O. Hen	RG
E12-11-003b	Study of J/ψ photoproduction off the deuteron	Y. Ilieva	RG
E12-11-003c	Quasi-real photoproduction on deuterium	F. Hauenstein	RG (*)

(*) Joined RGB from fall run onwards

Common features to all experiments of RG-B:

- **Liquid deuterium target**
- **Beam energy: « 11 » GeV**

Run Group B running time

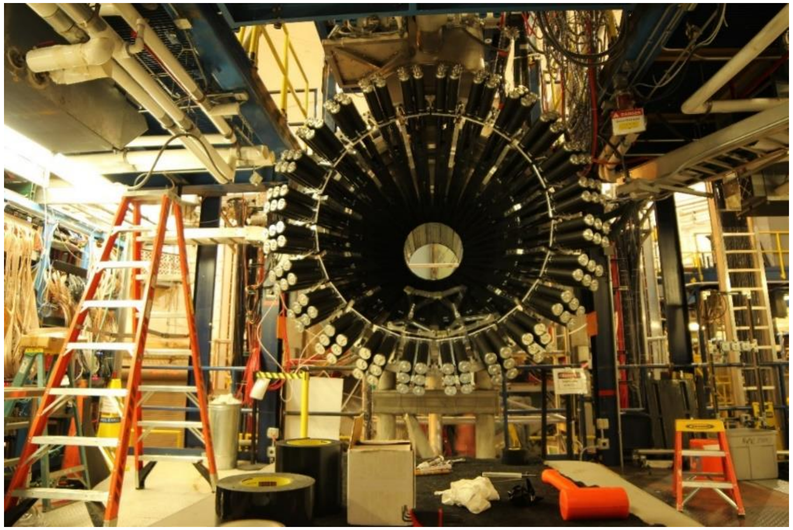
Scheduled beam time:
Spring: Febuary 6th - March 25th 2019
Fall: December 3rd –20th 2019
Winter: January 6th – 30th 2020

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%

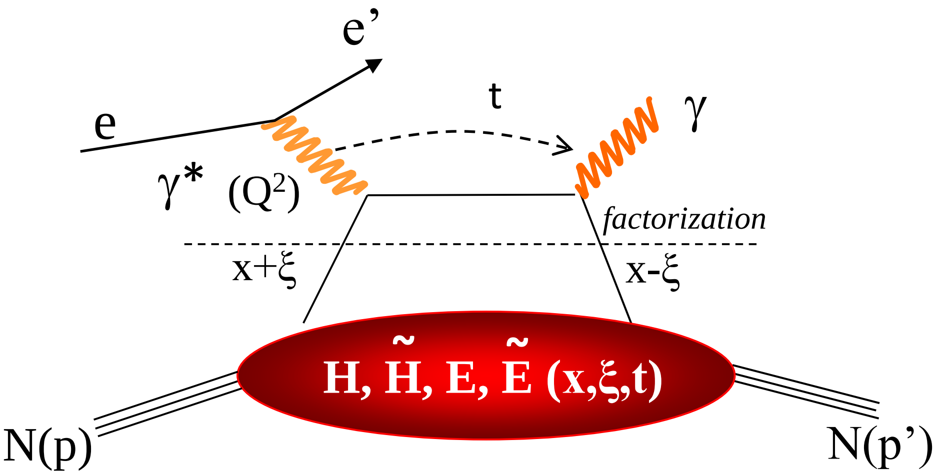
38.9 total PAC days according to ABUs
→ **43.2% of the approved 90 PAC days**
<u>**51 PAC days left to run**</u>



Status of data processing:
- spring dataset calibrated
- spring "cooking" completed (**Sep 2nd**)
- fall dataset: calibrations underway
- winter: preliminary calibrations

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

Interest of DVCS on the neutron



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

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

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

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:

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

Unpolarized beam, transversely polarized target:

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

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

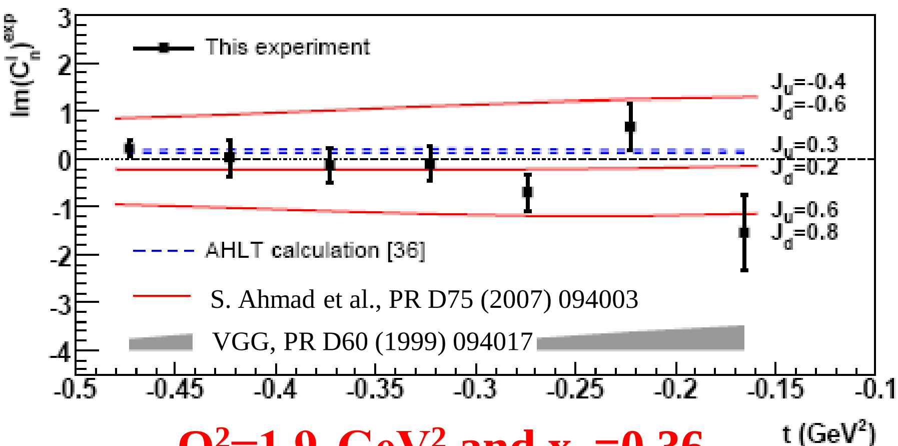
$\vec{e}d \to e\gamma(np)$

DVCS on the neutron in Hall A at 6 GeV

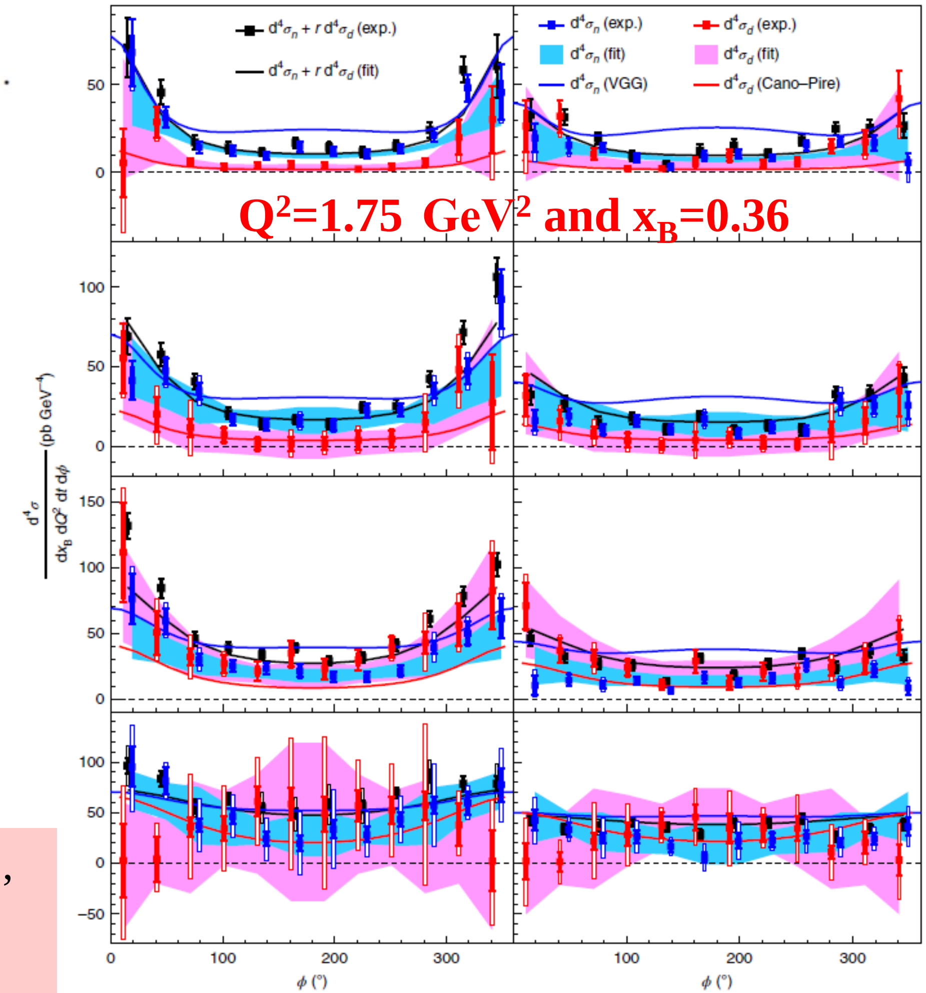
$$D(e,e'\gamma)X - H(e,e'\gamma)X = n(e,e'\gamma)n + d(e,e'\gamma)d + \ldots$$

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

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



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



- 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)**

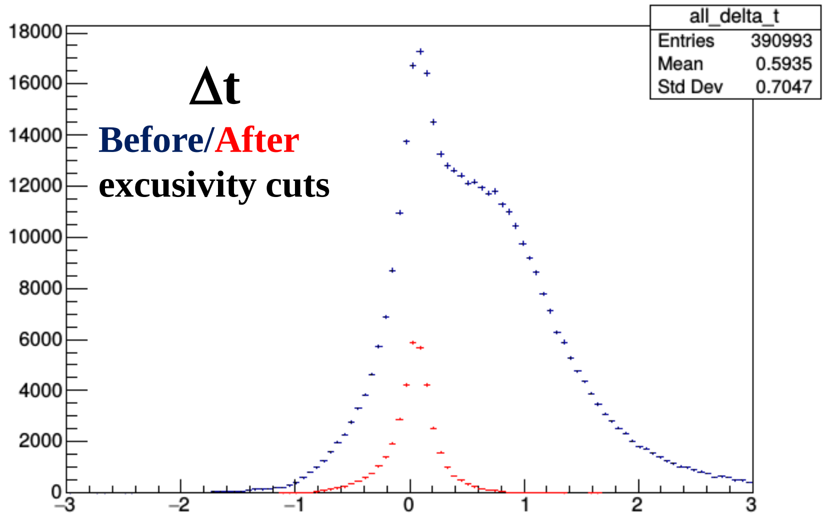
nDVCS with RGB data

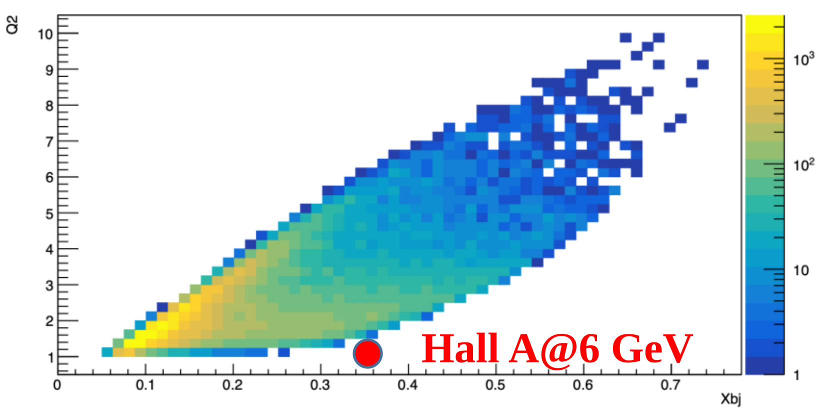
$\vec{e}d \rightarrow en\gamma(p)$

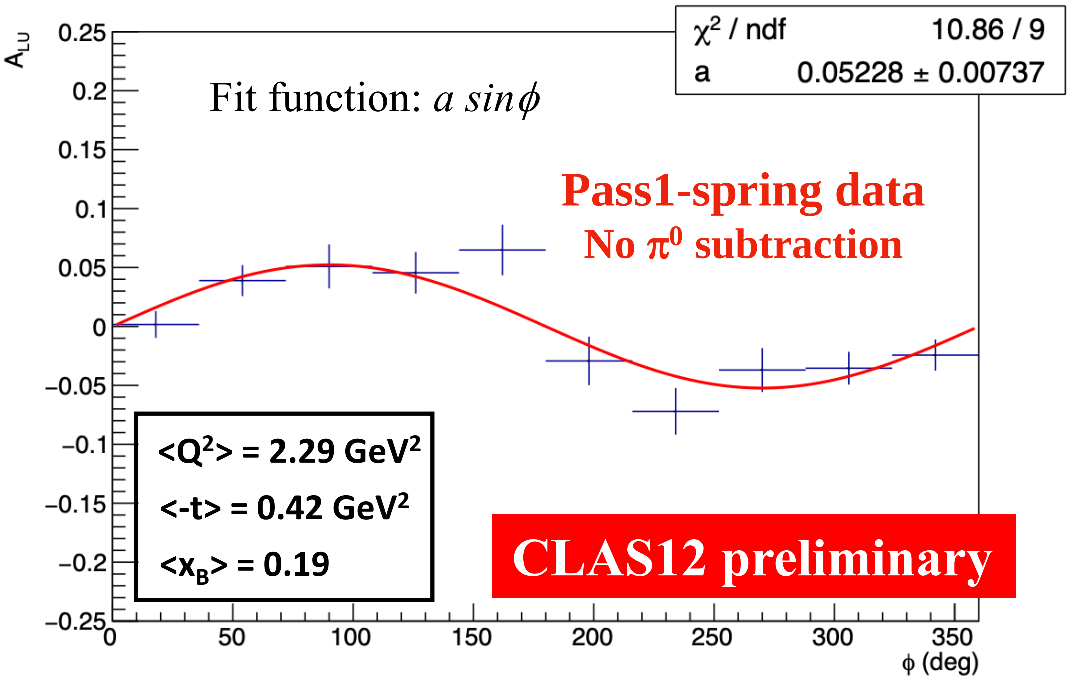
First-time measurement of BSA for nDVCS with exclusive final state selection:

- 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
- Work ongoing on π^0 subtraction, fiducial cuts, etc…

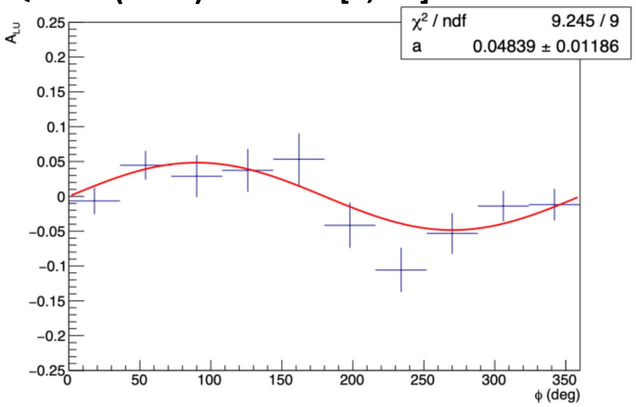
A. Hobart, K. Price, S. N. (IJCLab Orsay)

nDVCS raw BSA vs ϕ in 1-dim. bins

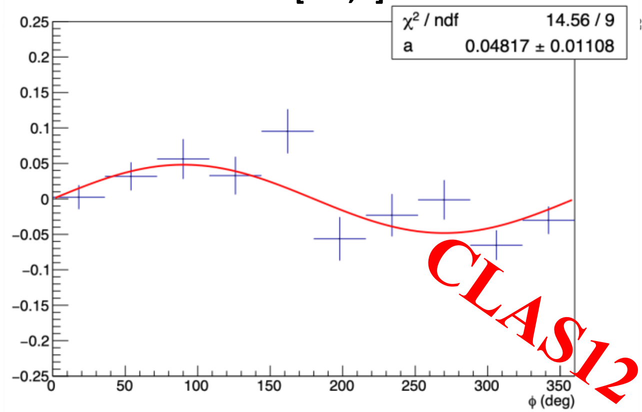
First-time measurement

Q^2 bins (GeV^2)

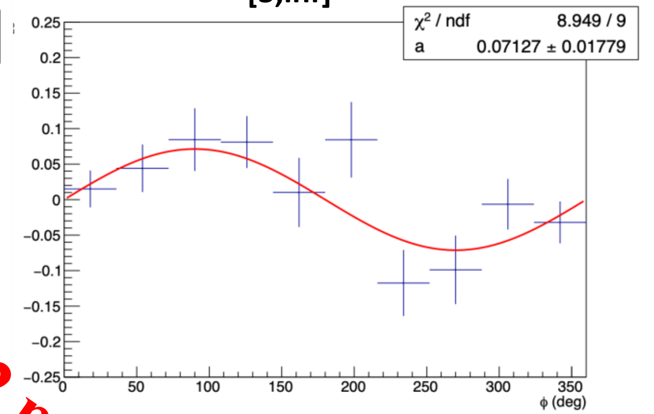
[1,1.8]



[1.8,3]



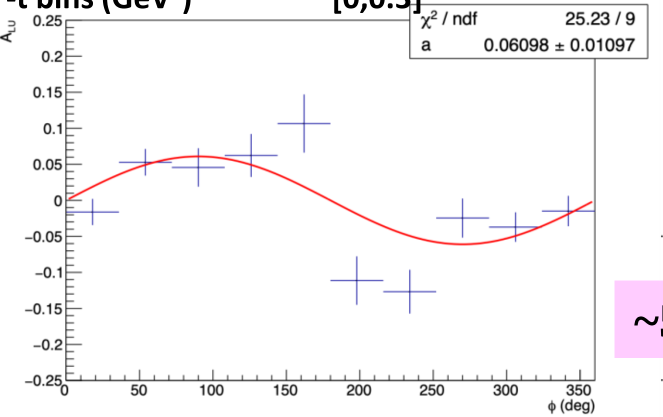
[3,inf]



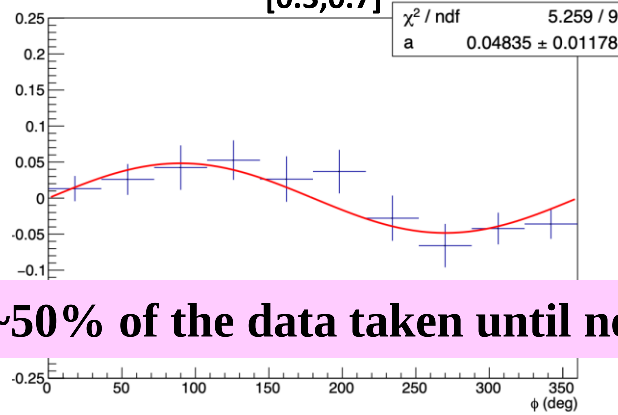
CLAS12 preliminary

-t bins (GeV^2)

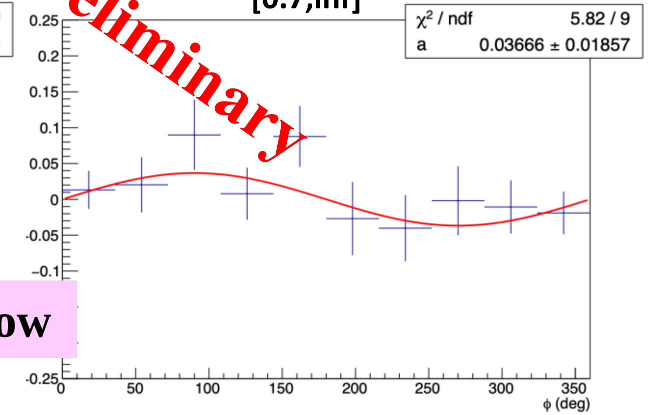
[0,0.3]



[0.3,0.7]



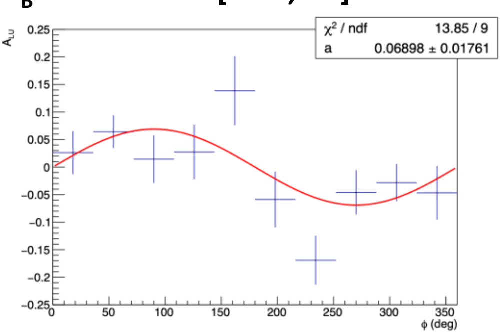
[0.7,inf]



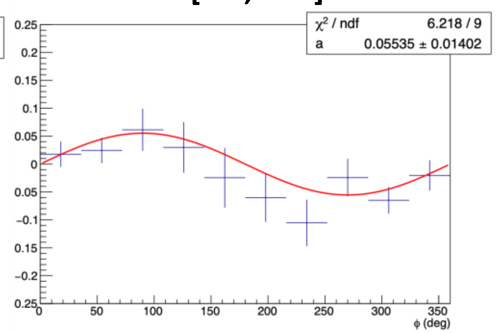
~50% of the data taken until now

x_B bins

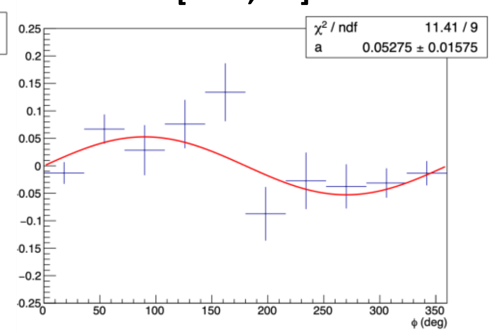
[0.05,0.1]



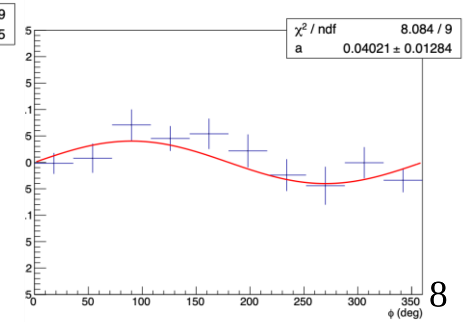
[0.1,0.14]



[0.14,0.2]



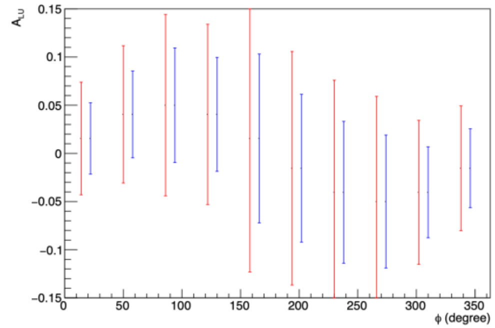
[0.2,inf]



Q^2 bins

Projections for nDVCS vs ϕ in 3-dim. bins

[4,inf]

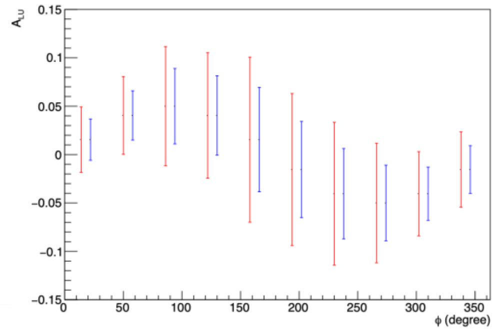


-t bin [0,0.35] GeV²

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**

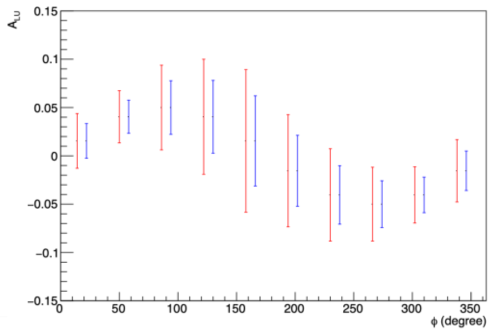
[3,4]

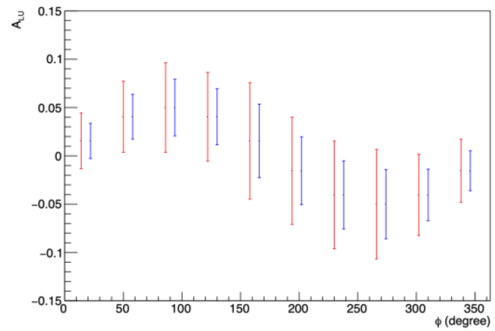


$$\sigma_A = \frac{1}{P_b} \cdot \frac{\sqrt{1 - P_b^2 A^2}}{\sqrt{N}}$$

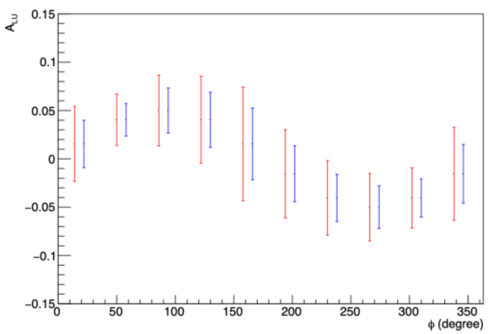
Existing data:
Relative error >100%, worse at high Q^2, low –t, central ϕ → crucial kinematics for GPDs and Ji's sum rule

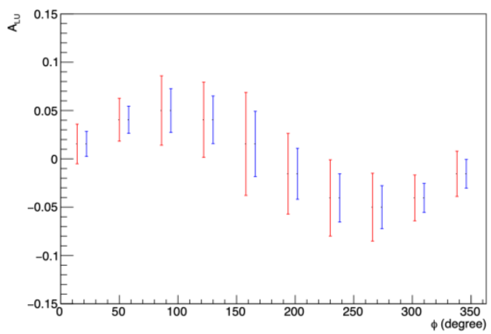
[2,3]

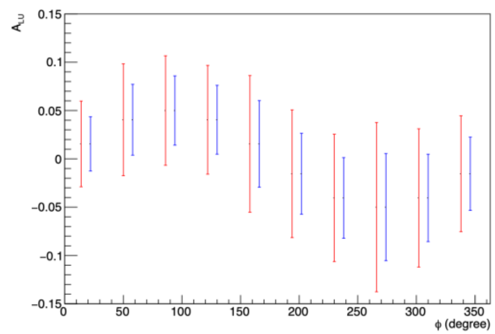




[1,2]







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

Projections for nDVCS vs ϕ in 3-dim. bins

Q^2 bins

-t bin [0.35,inf] GeV^2

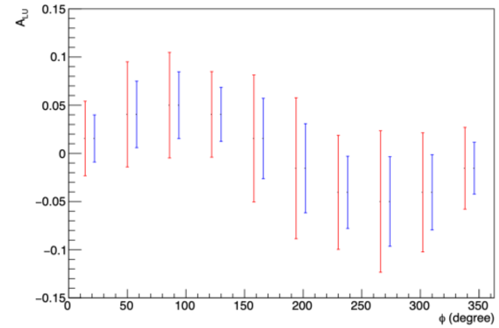
Data-driven projections for the expected uncertainties, starting from current yield per bin (Y):

- **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**

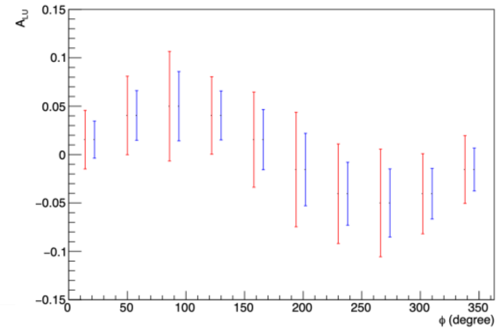
$$\sigma_A = \frac{1}{P_b} \cdot \frac{\sqrt{1 - P_b^2 A^2}}{\sqrt{N}}$$

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

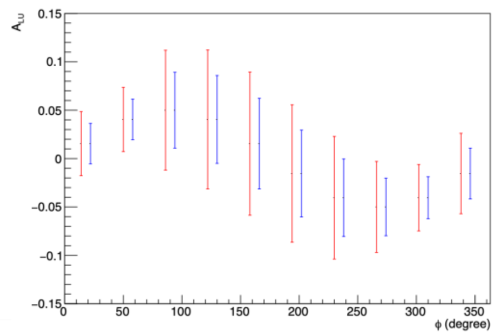
[4,inf]

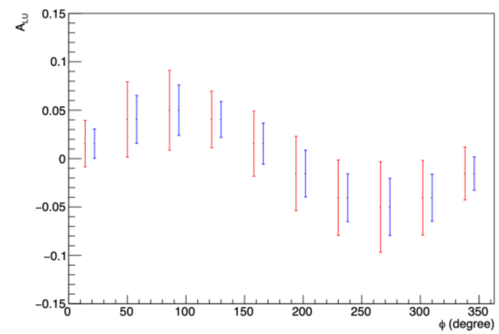


[3,4]

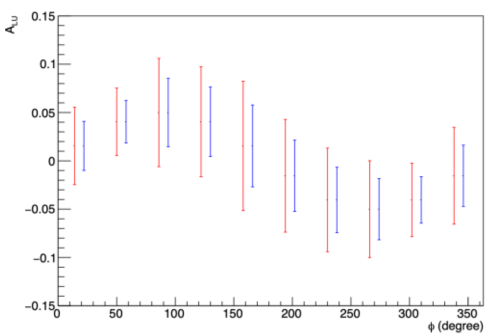


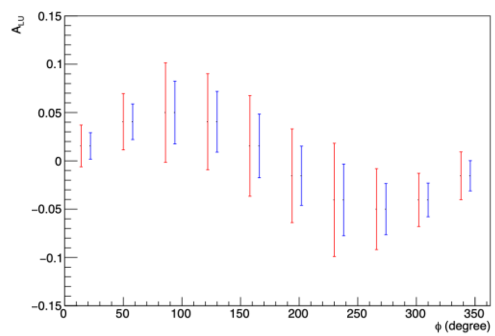
[2,3]

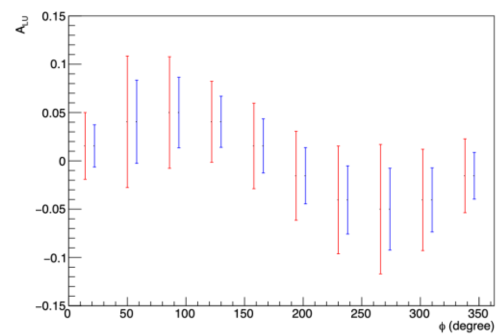




[1,2]







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

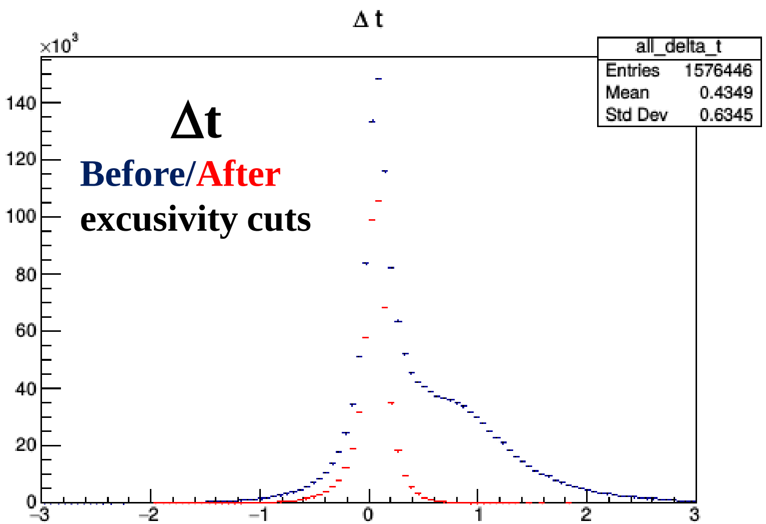
x_B bins

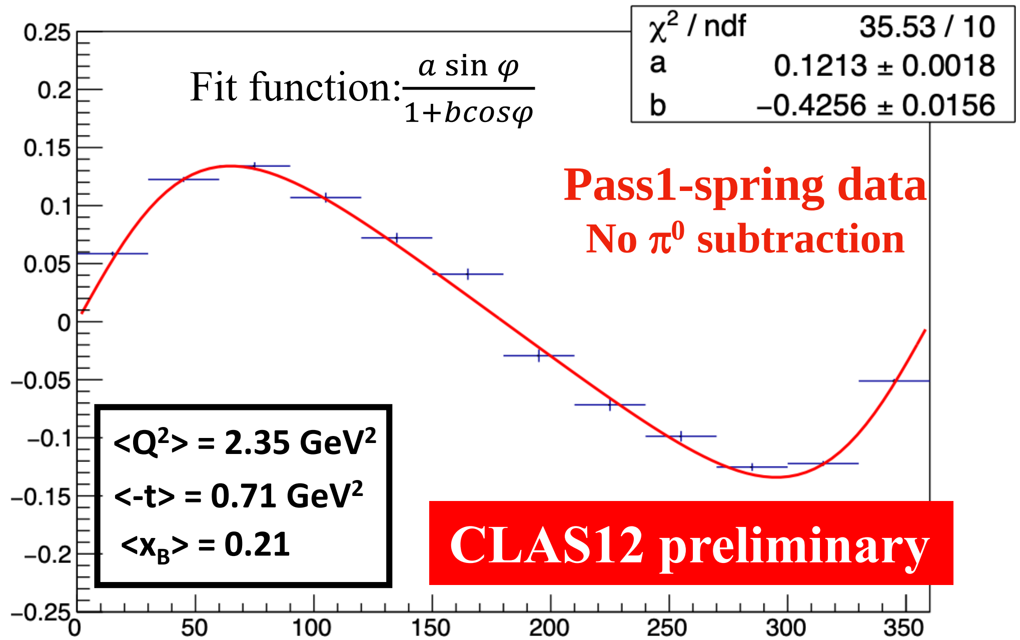
Incoherent pDVCS on deuterium

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

- 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:

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





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

- 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…

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

pDVCS raw BSA vs ϕ in 3-dim. bins

First-time measurement

Q^2 bins (GeV^2)

[4,inf]

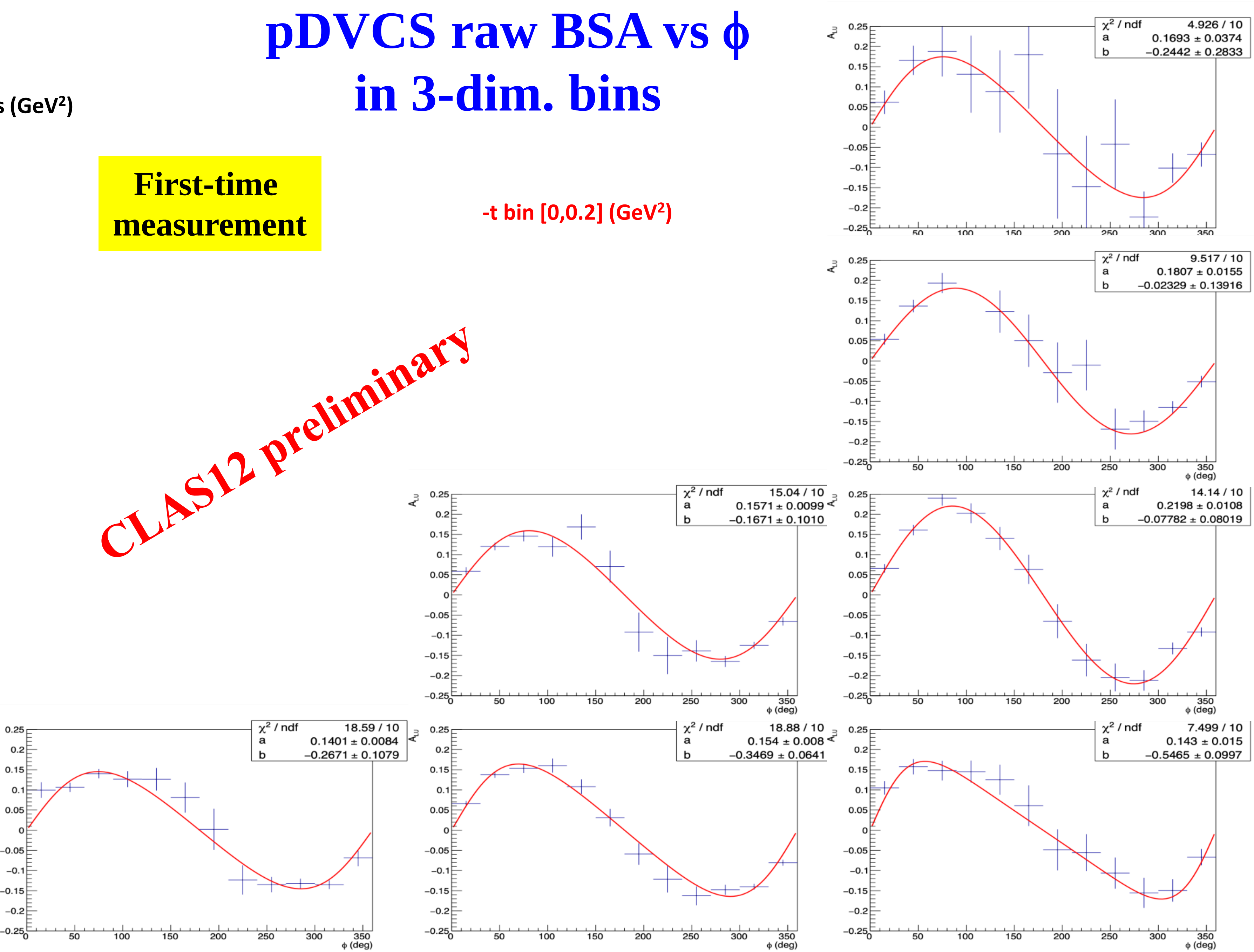
[3,4]

[2,3]

[1,2]

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

CLAS12 preliminary



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

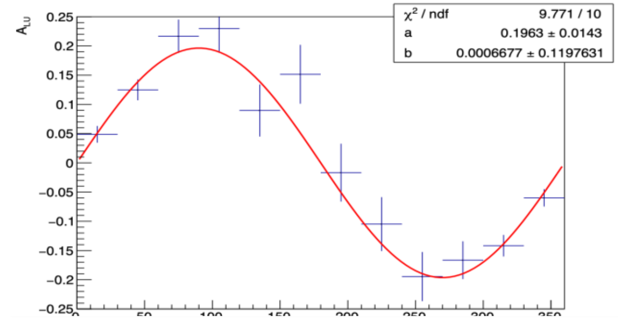
pDVCS raw BSA vs ϕ in 3-dim. bins

Q^2 bins (GeV^2)

[4,inf]

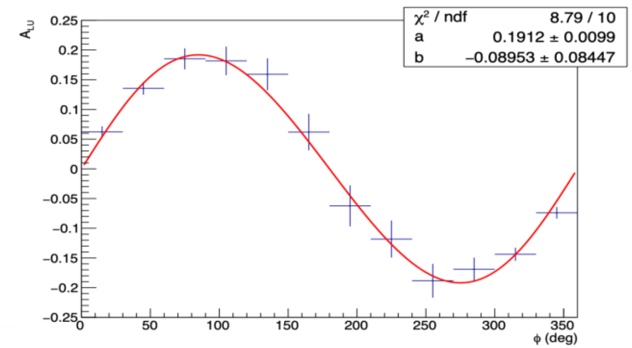
First-time measurement

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

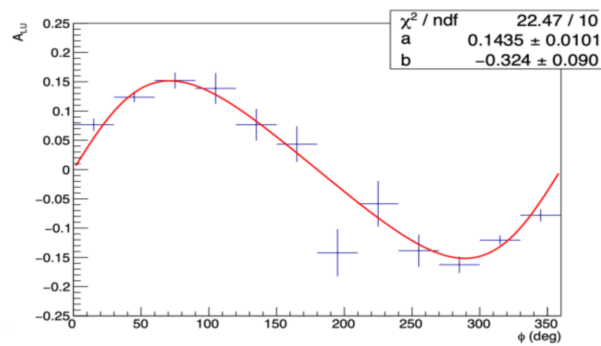


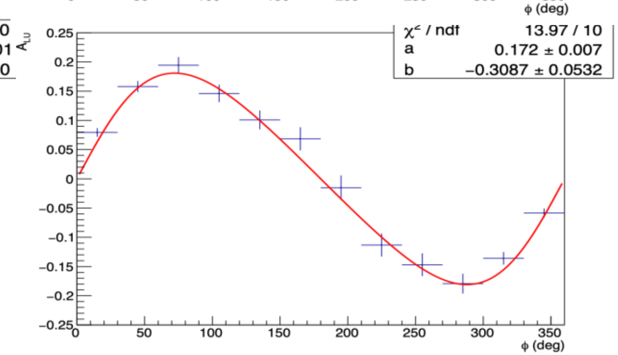
[3,4]

CLAS12 preliminary

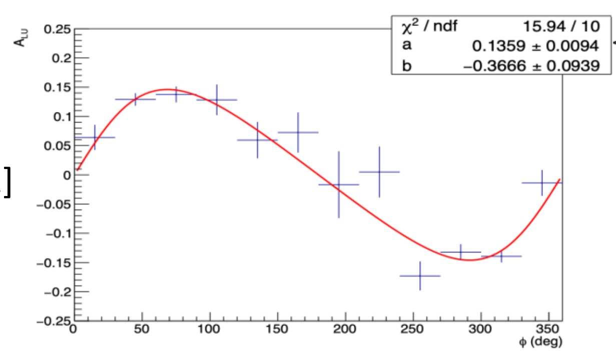


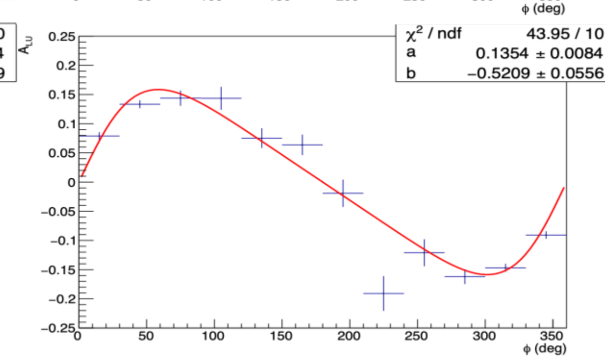
[2,3]

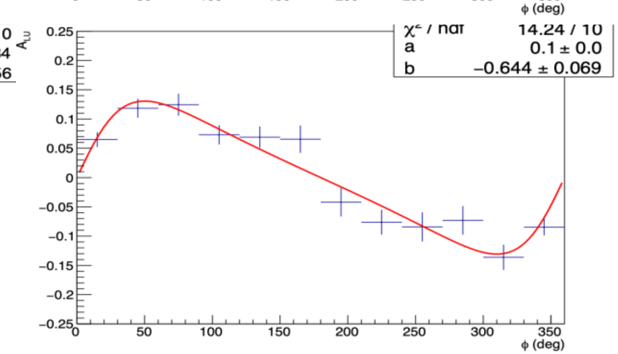




[1,2]







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

pDVCS raw BSA vs ϕ in 3-dim. bins

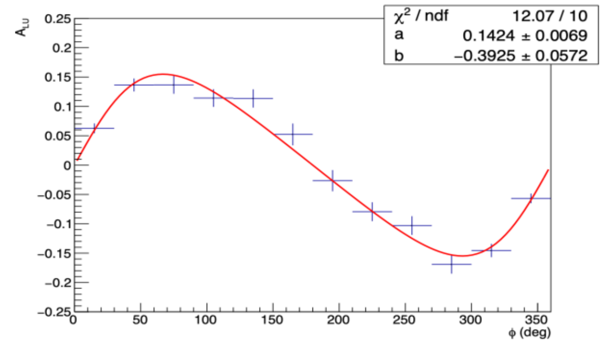
Q^2 bins (GeV^2)

First-time measurement

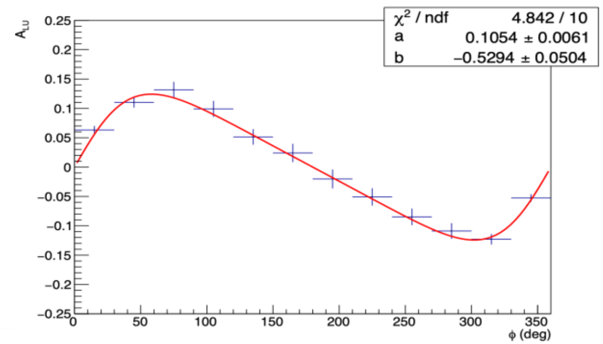
-t bin [0.4,inf] (GeV^2)

CLAS12 preliminary

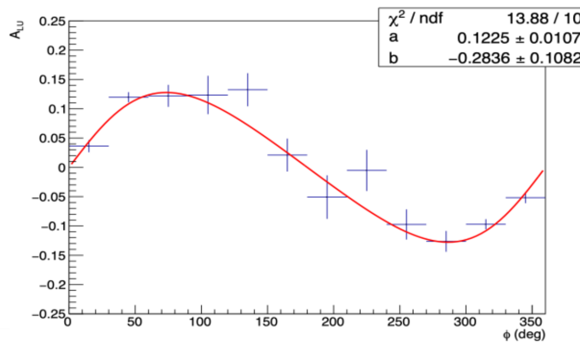
[4,inf]

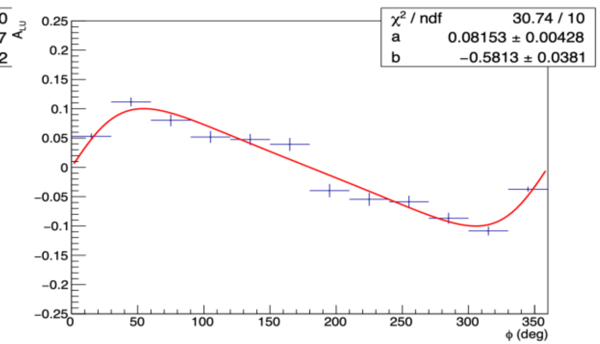


[3,4]

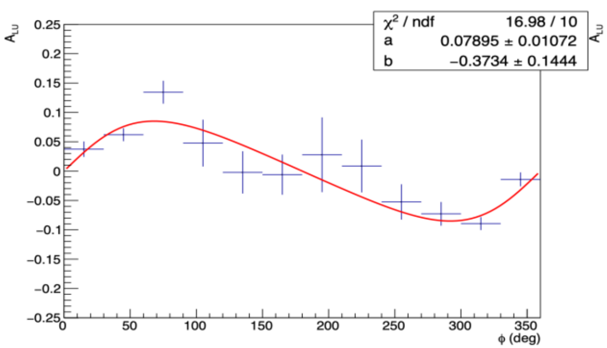


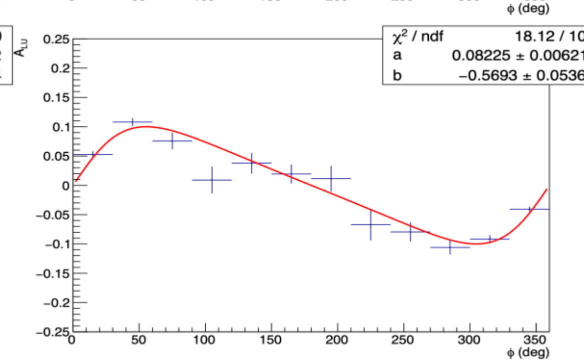
[2,3]

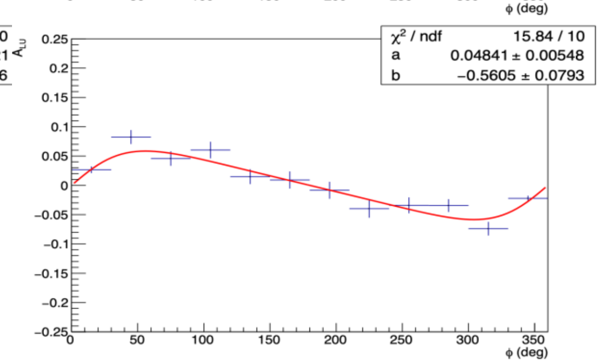




[1,2]



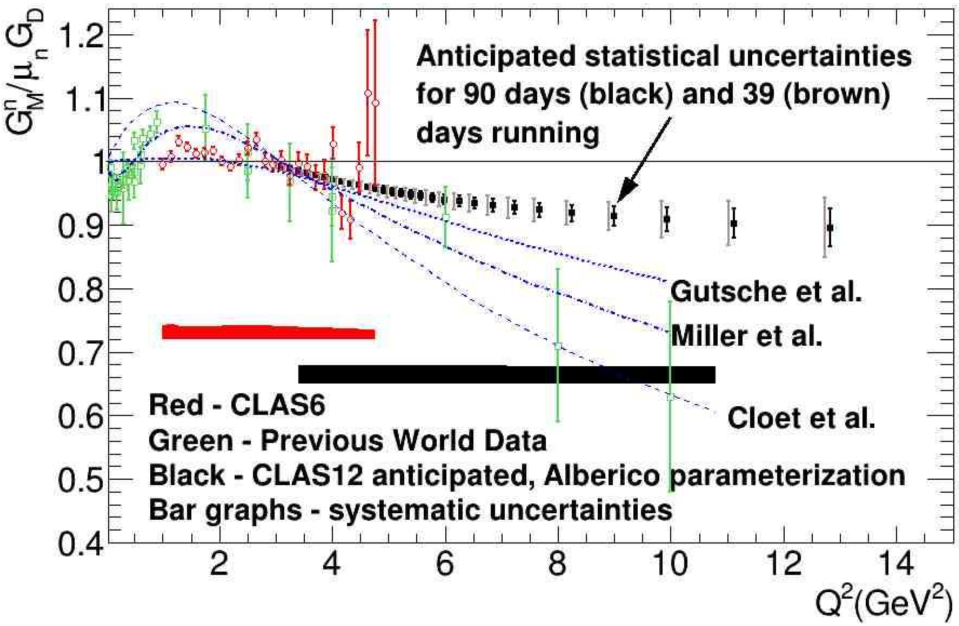




[0.05,0.1] [0.1,0.17] [0.17,inf] **x_B bins**

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

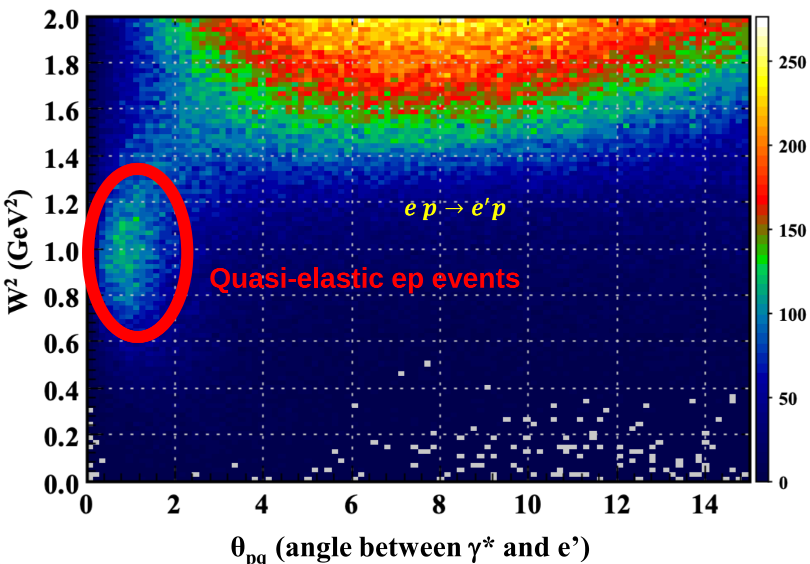
Goal: Extract G_M^n at high Q^2 using the ratio of quasi-elastic e-n and quasi-elastic e-p on deuteron: $R = \frac{d(e,e'n)p}{d(e,e'p)n}$

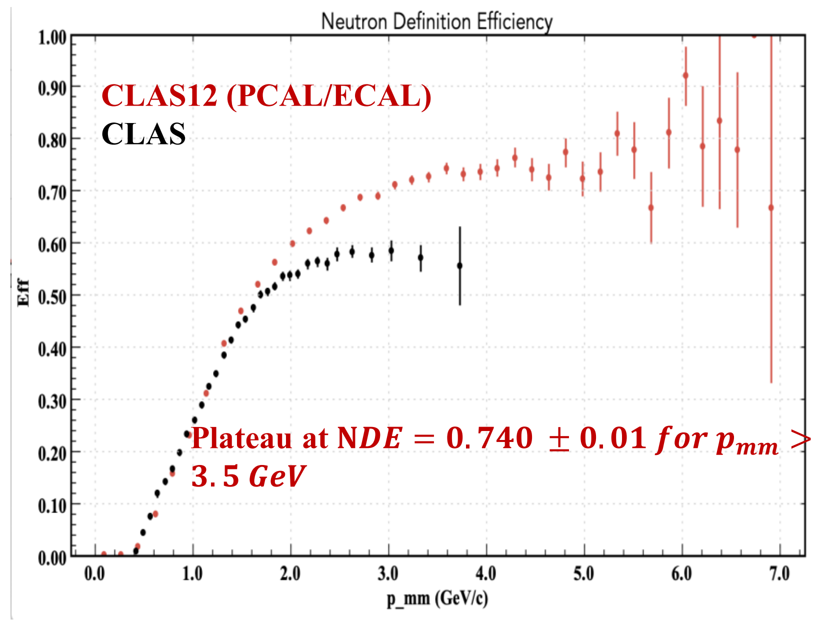


90-days RG-B run time will extend the reach in Q^2 where no data exist with high statistical precision

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





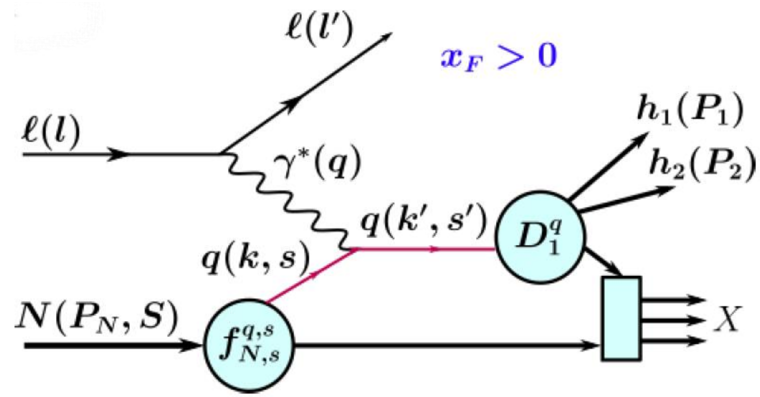
L.Baashen, B. Raue (FIU), G. Gilfoyle (U. Rich.), L.C. Smith (UVA)

Di-hadron Multiplicities

e N → e' $\pi^+ \pi^-$ X

Number of di-hadron pairs per DIS electron

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



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

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

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

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

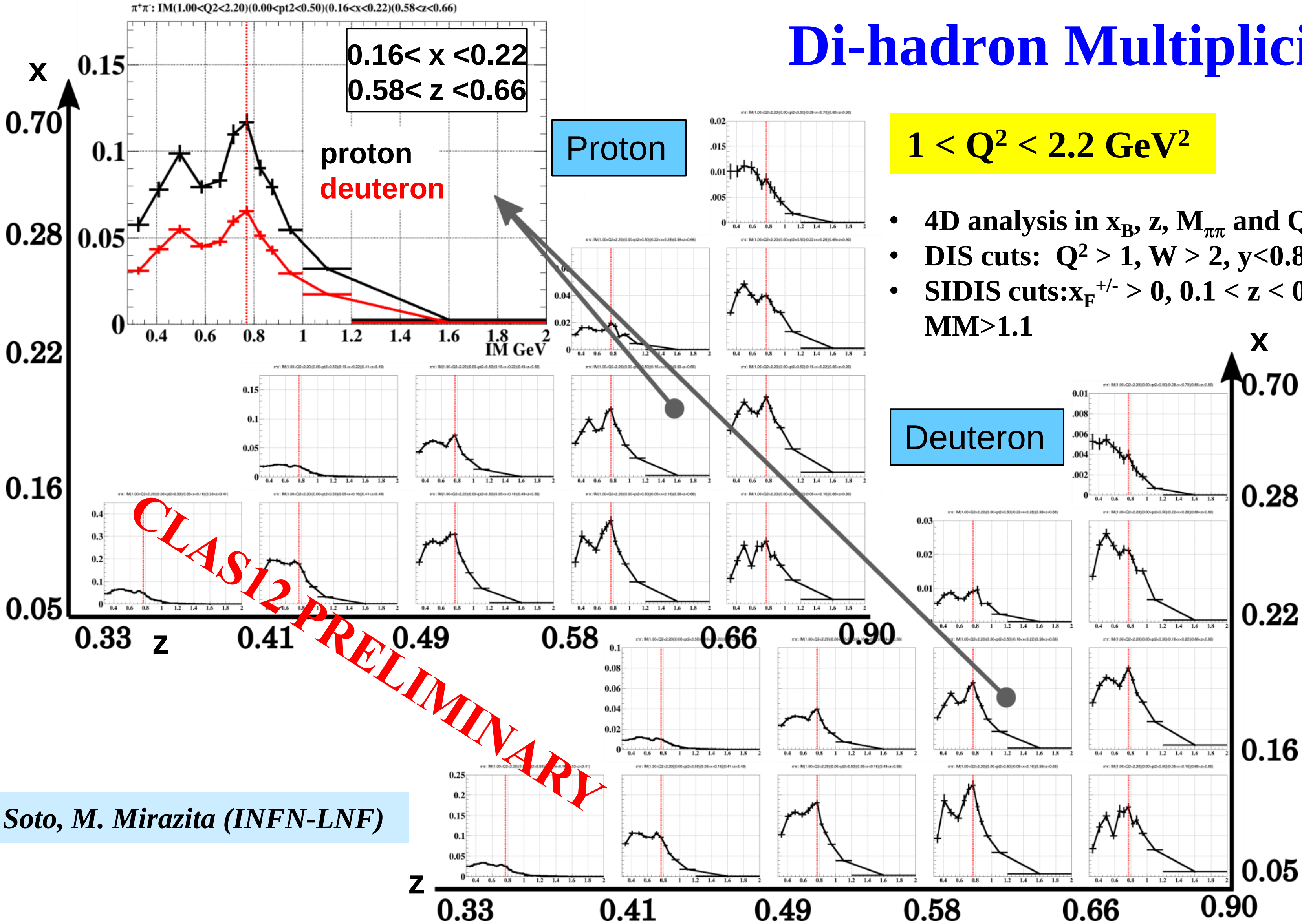
K_f → kinematic factors

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

Di-hadron Multiplicities

$1 < Q^2 < 2.2$ GeV^2

- **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**



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

Completion of the run will provide about x5 more statistics, allowing:
- **improved sensitivity in the high x and high Q^2 region**
- **better precision in extracting D_1^d**
- **access to TMD adding p_T dependence (5D analysis)**

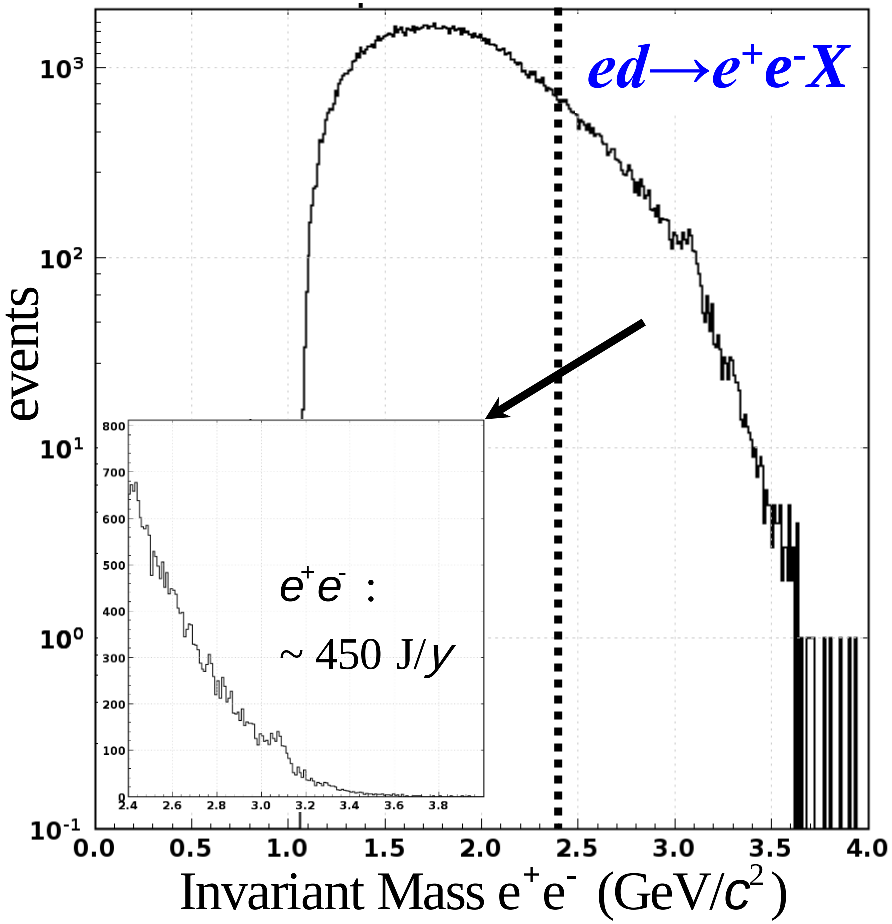
$$4M^p - M^d \to D_1^u$$

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

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).

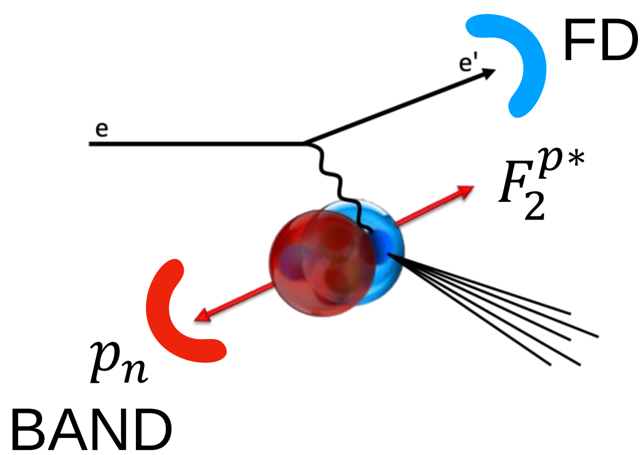
- The question about P_C pentaquark signal in photoproduction remains unresolved. Neutron channel is critical given that no positive signal in the proton channel has been reported from Halls D and C.
- This experiment remains the sole near-threshold exclusive study worldwide of re-scattering and coherent physics.

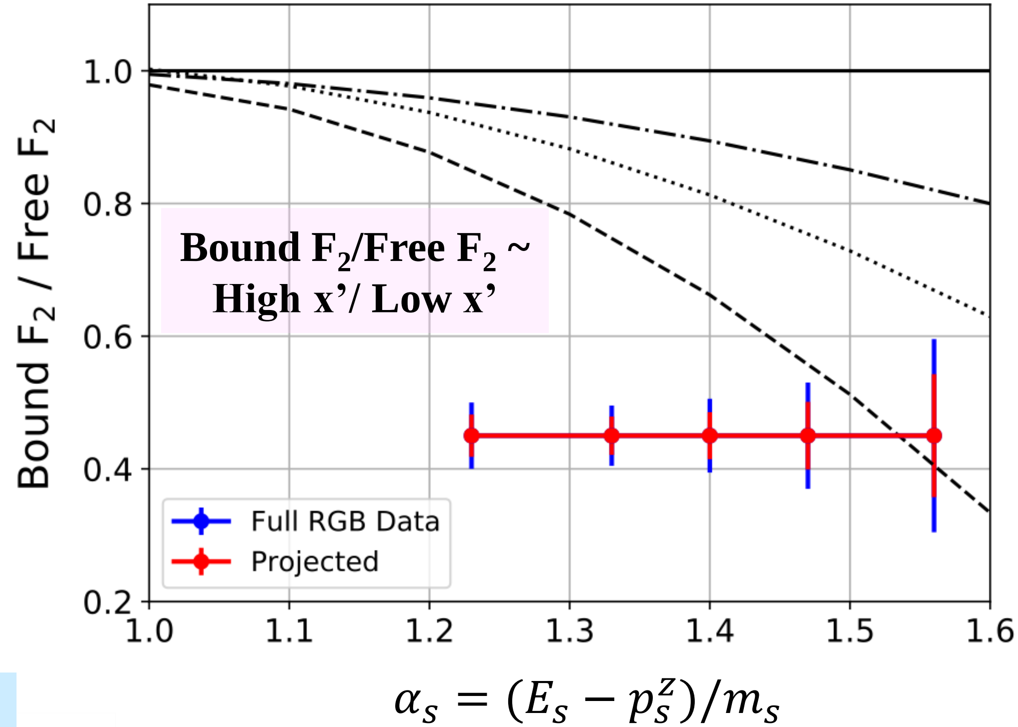
Q2: Data analysis and received data

- 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.

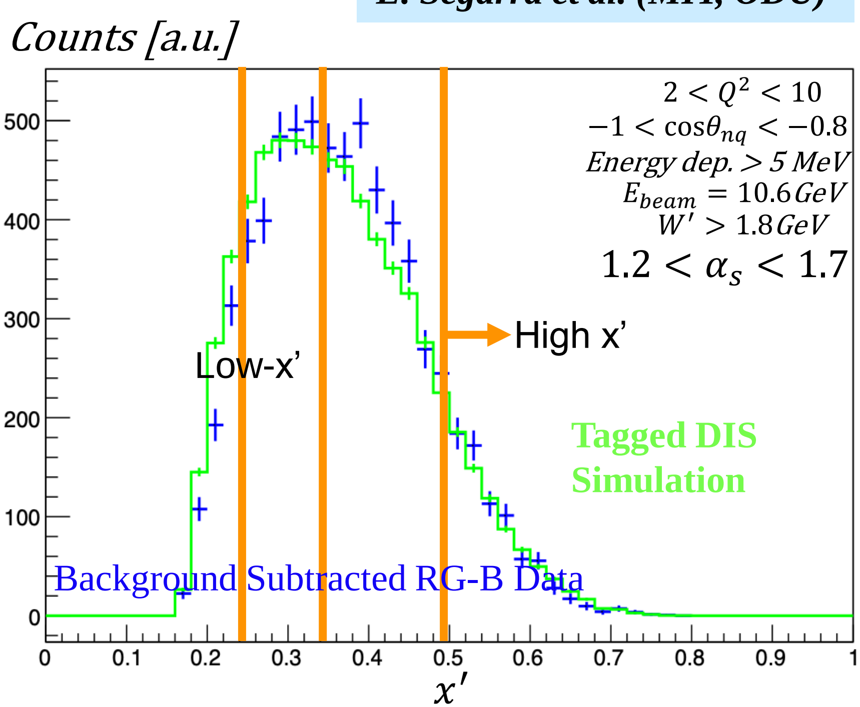
Q3: No request for reconsideration of allocated beam time or assigning scientific ranking (remains Run Group Proposal).

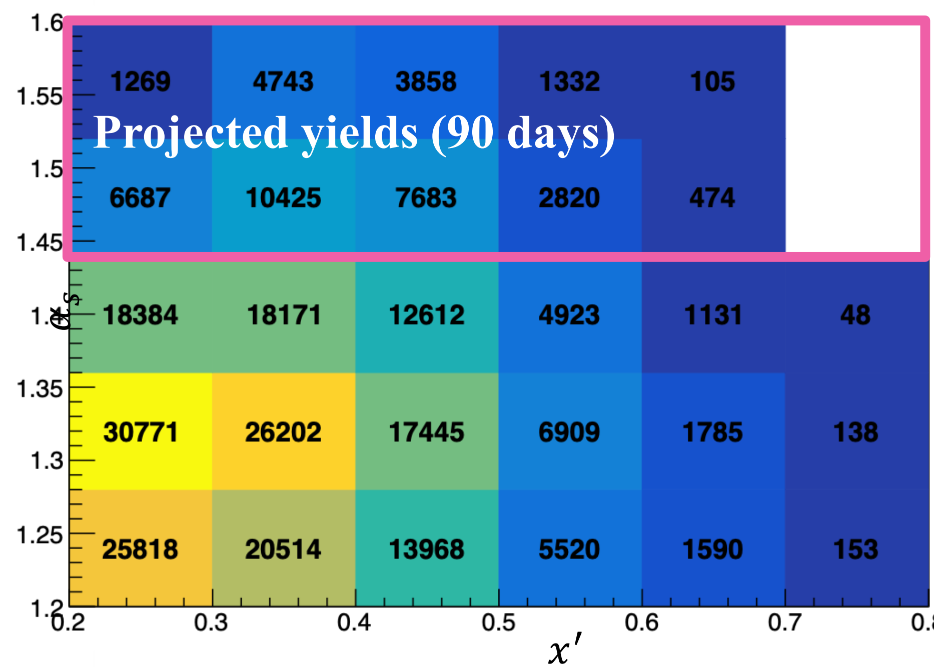
Study bound proton structure by tagging the neutron





E. Segarra et al. (MIT, ODU)





Conclusions and beam-time request

- 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)
- Calibrations well advanced for Fall and Winter datasets
- **Physics analyses in good shape**: n/p/d-DVCS, G^n_M, Di-hadron SIDIS, J/ψ, Tagged-DIS, n/p-DVMP(π^0)
- Analysis of K-SIDIS in progress (RG-A being analyzed first)

<u>We request the PAC to allow us to run the remainder 51 days of our approved beam time:</u>

✓ ***We will measure the BSA for nDVCS in 4-D (Q^2, x_B, -t, ϕ) with acceptable statistical errors, exploiting the full available phase-space, and possibly at a constant beam energy, thus delivering the originally proposed physics output and providing unprecedented constraints on the GPD E***

✓ ***We will achieve high precision at high Q^2 for G^n_M, where no other data exist***

✓ ***We will triple the statistics for K-SIDIS, as the 51 more days will run with 2 RICH sectors***

✓ ***We will allow precise extraction of the Di-hadron FF for u and d quarks via the first-time measurement of di-hadron multiplicities***

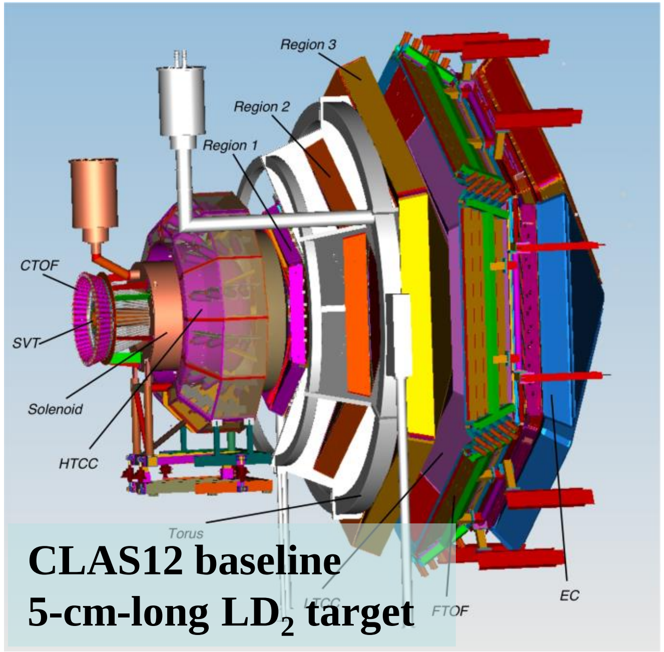
✓ ***We will provide a first-time measurement of J/ψ photoproduction on deuterium***

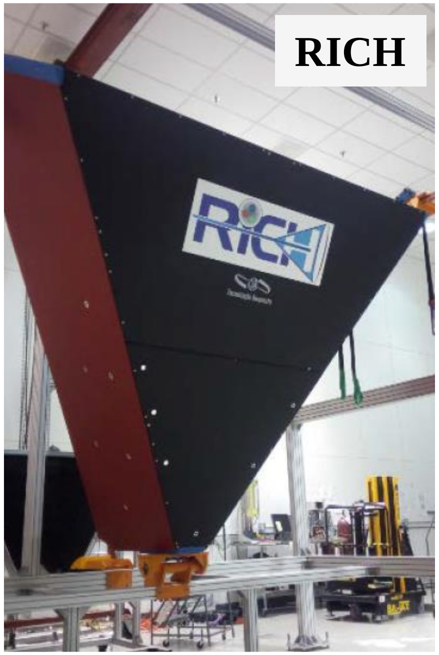
✓ ***We will perform a multi-dimensional study of SRC on a bound proton***

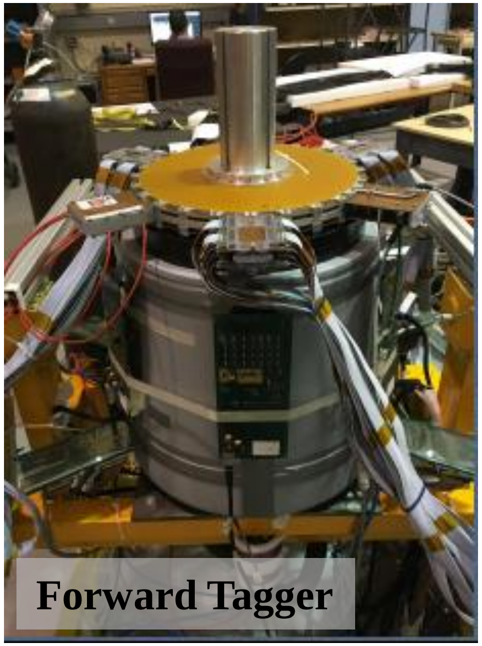
✓ ***We will provide first-time pioneering measurements for new channels (d-DVCS, n-DVMP(π^0))***

Back-up slides

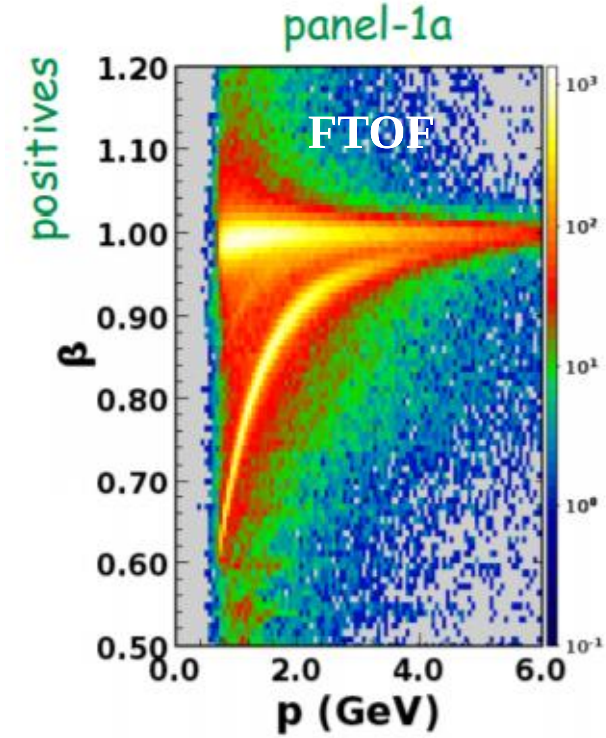
Experimental setup

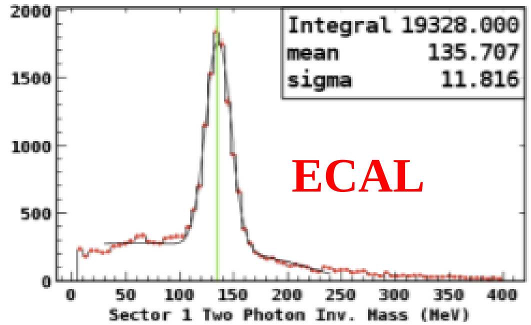




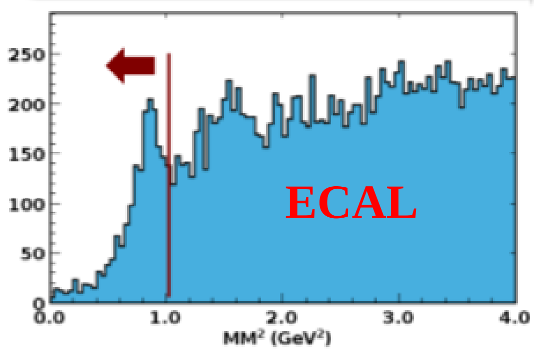


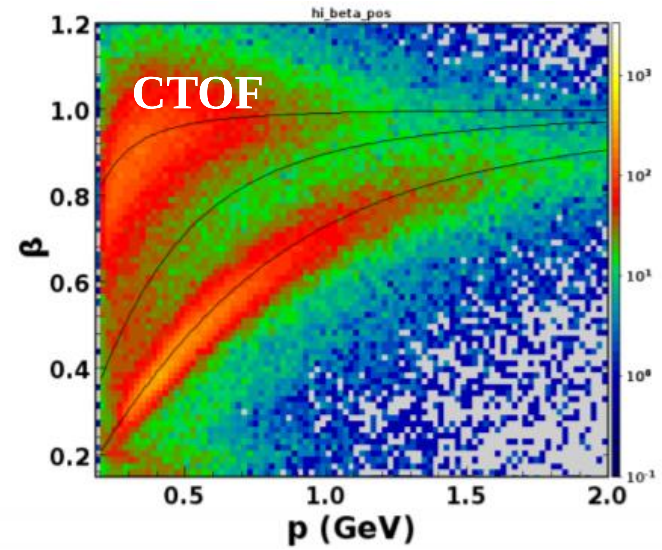
Data quality of RGB data

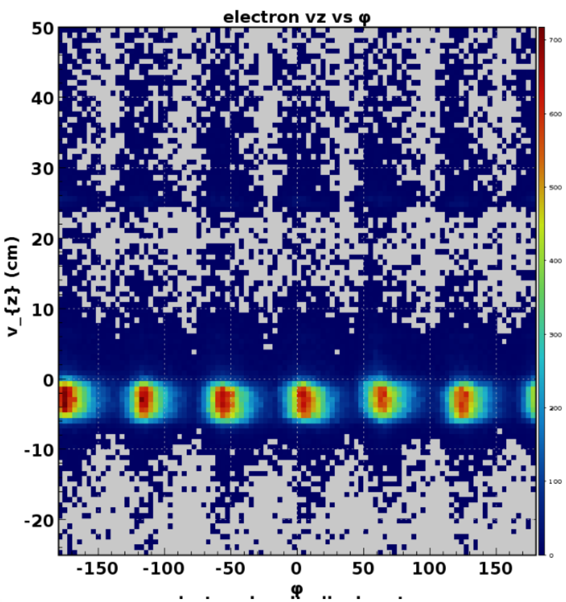


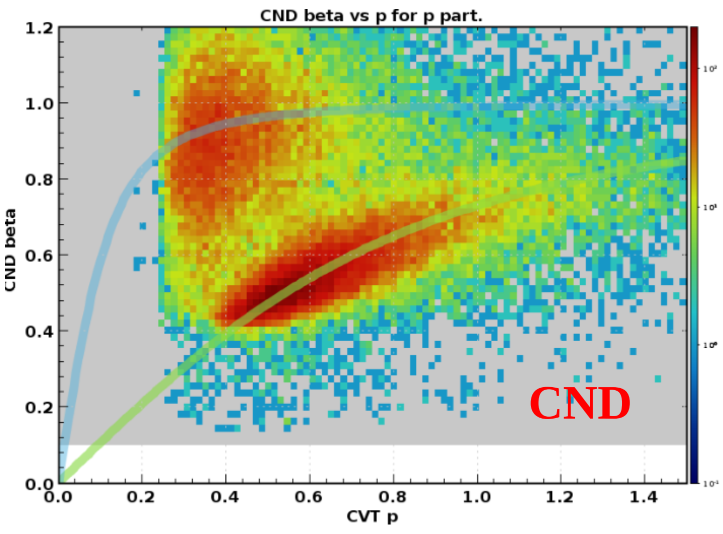


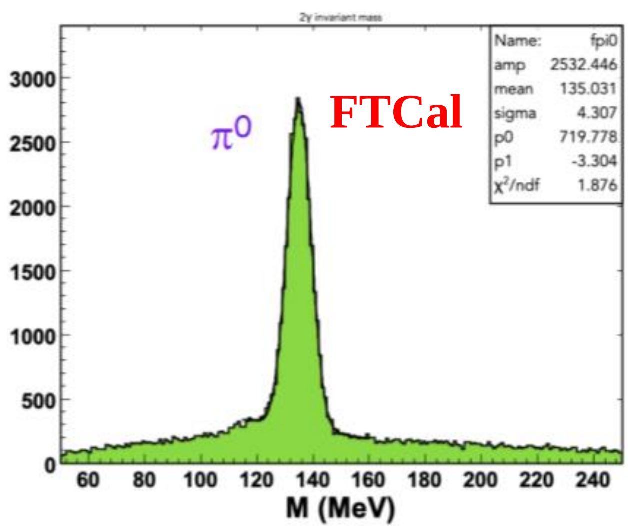
tagged neutrons d(e,e′π⁺)nn











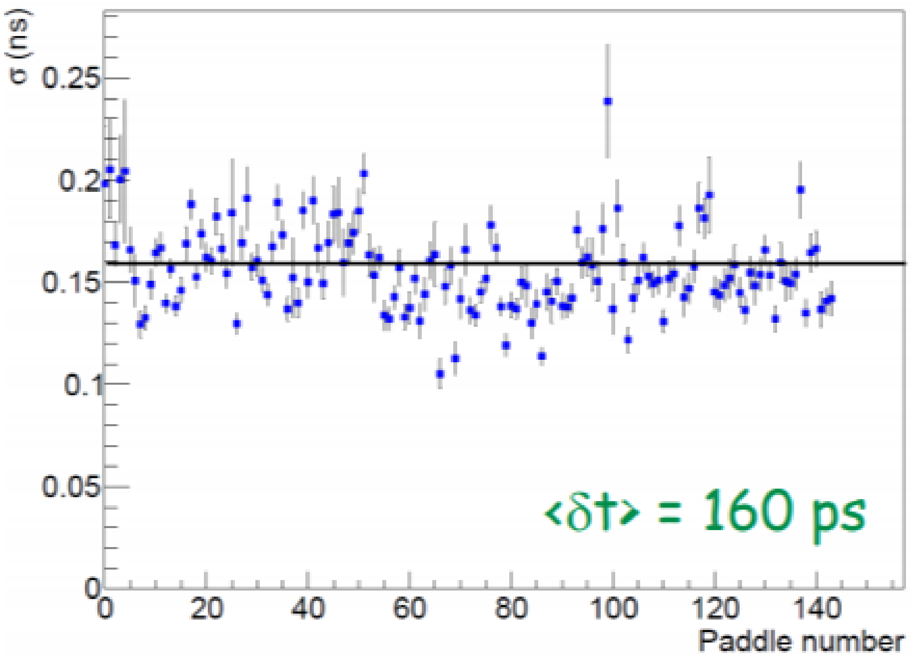
CND: performances with CLAS12 data

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 δp/p < 10% ✓
- neutron detection efficiency ~10% ✓

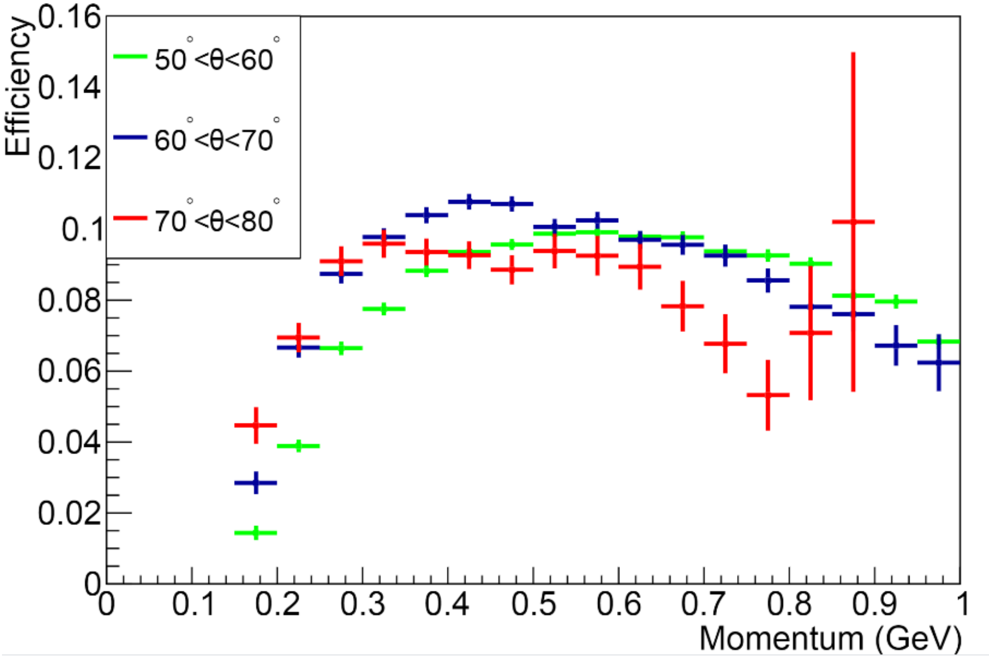
CND design: **scintillator barrel** - 3 radial layers, 48 bars per layer **coupled two-by-two** downstream by a **"u-turn" lightguide,** 144 long light guides with **PMTs** upstream

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

Timing resolution per paddle (RGB data)



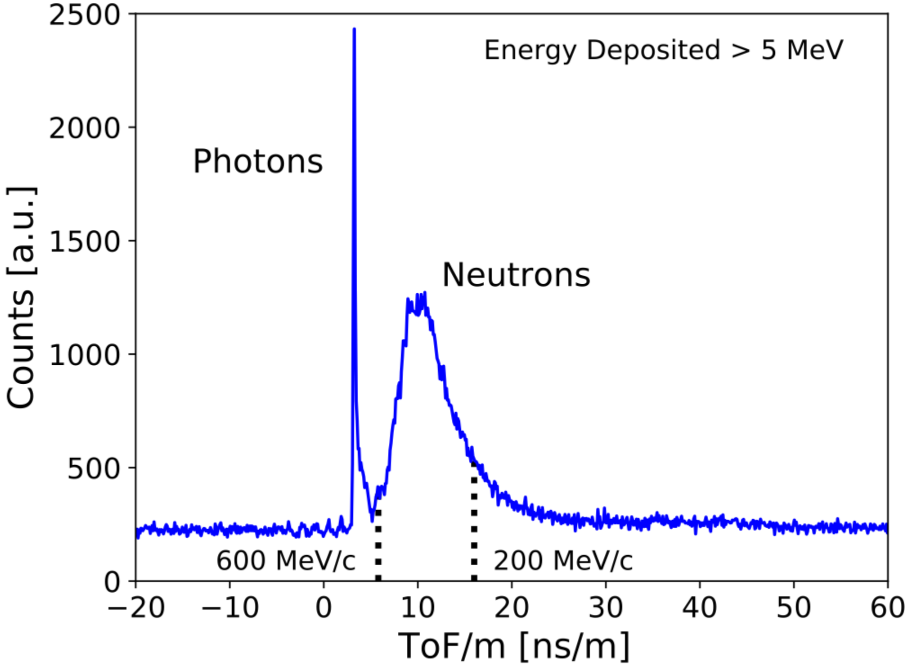
Neutron efficiency from ep→e'nπ⁺ (RGA data)

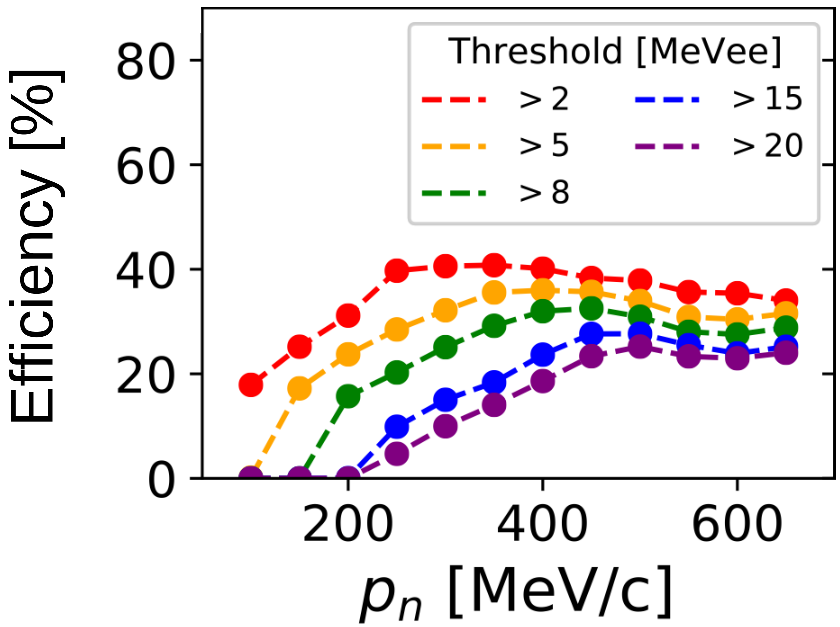


BAND: performance with CLAS12

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%





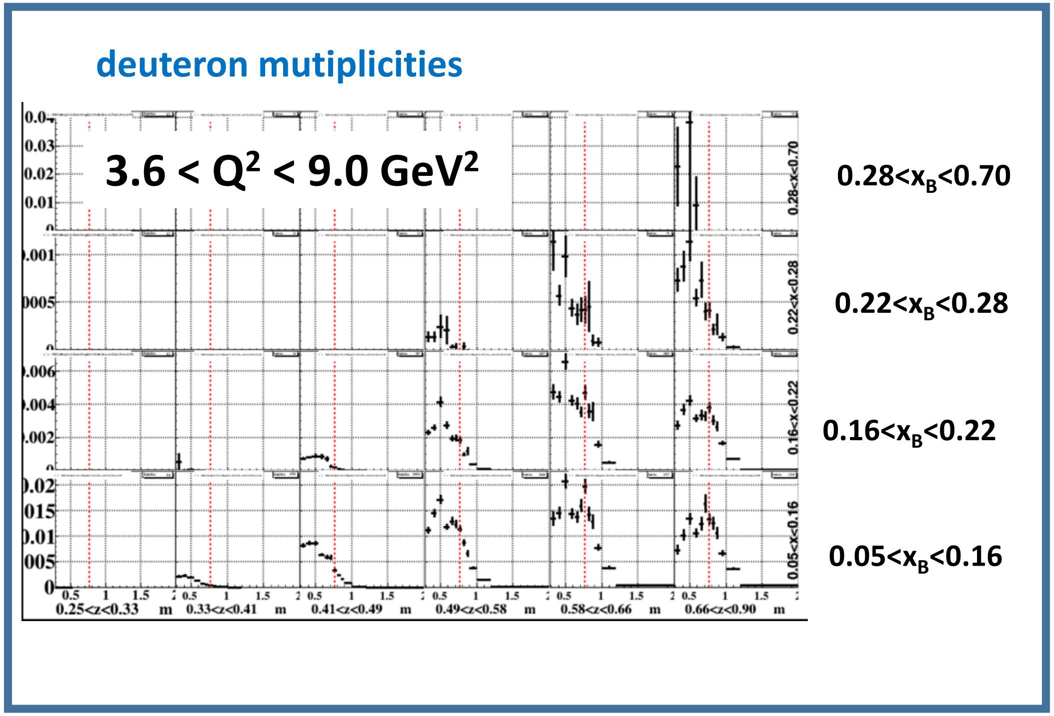
E.P. Segarra et al., NIM A 978 (2020)

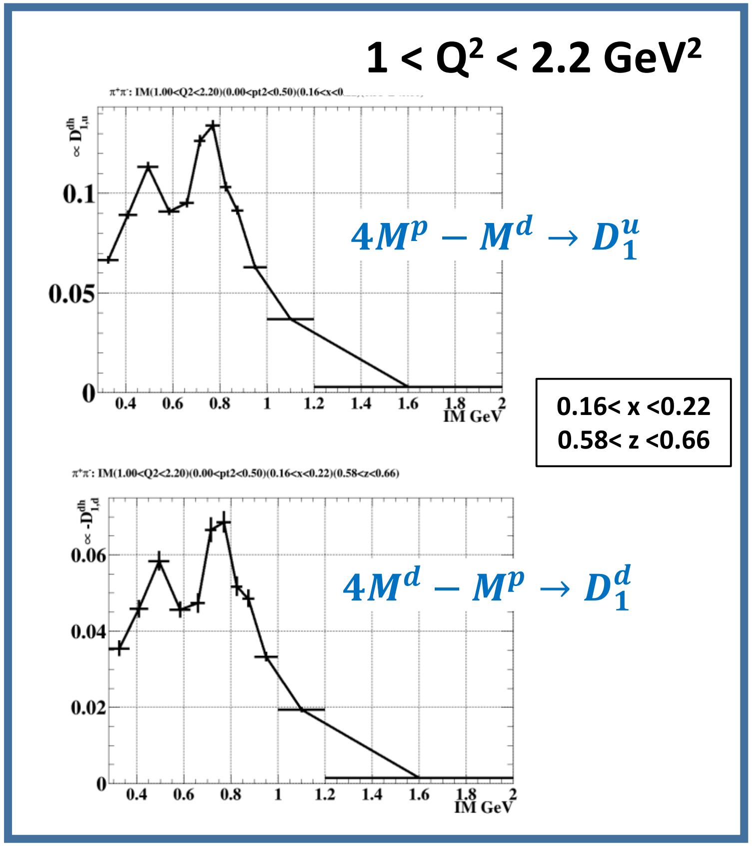
SIDIS di-hadron will full statistics

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





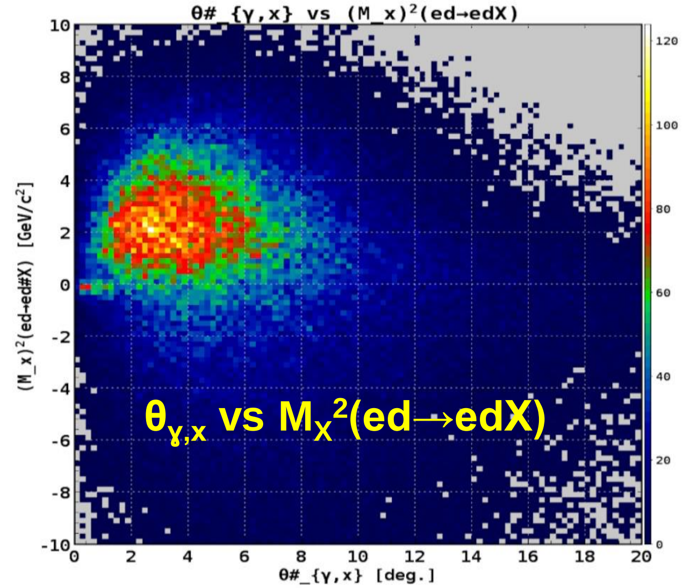

```
RGA: pi+pi-/pi+: 0.067,  pi+pi-/pi-: 0.196
RGB: pi+pi-/pi+: 0.073,  pi+pi-/pi-: 0.167
```

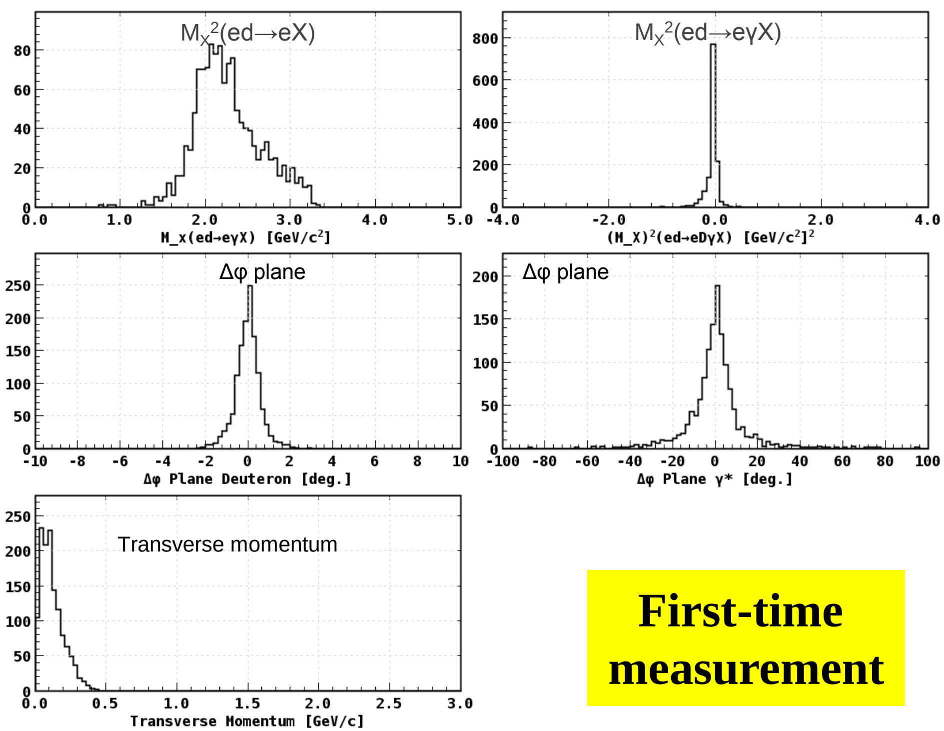
J. Dickovick,
A. Biselli
B. (Fairfield U.)

Coherent Deuteron DVCS

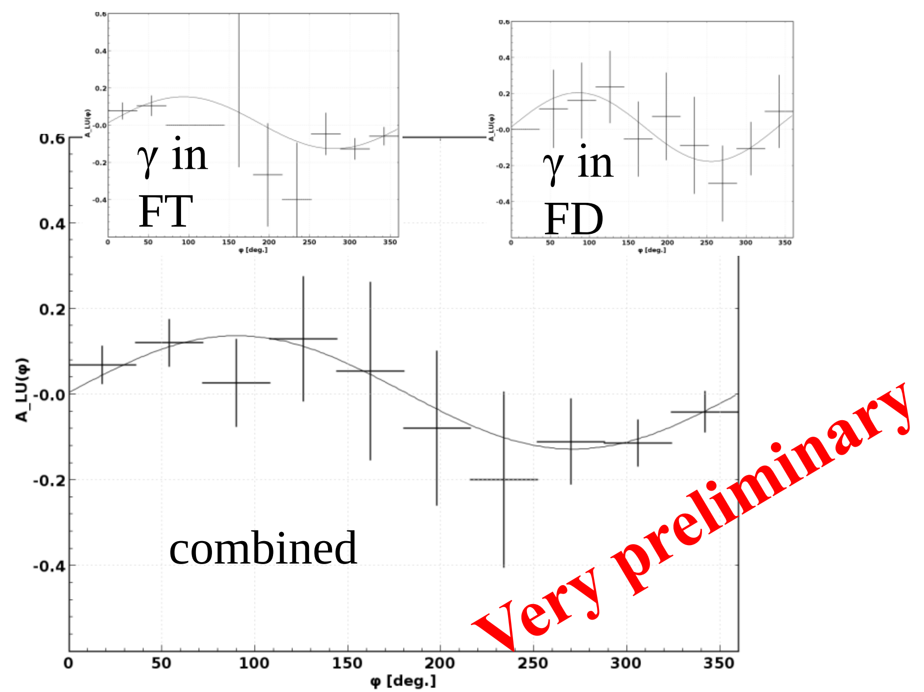
$\vec{e}d \rightarrow ed\gamma$

- 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

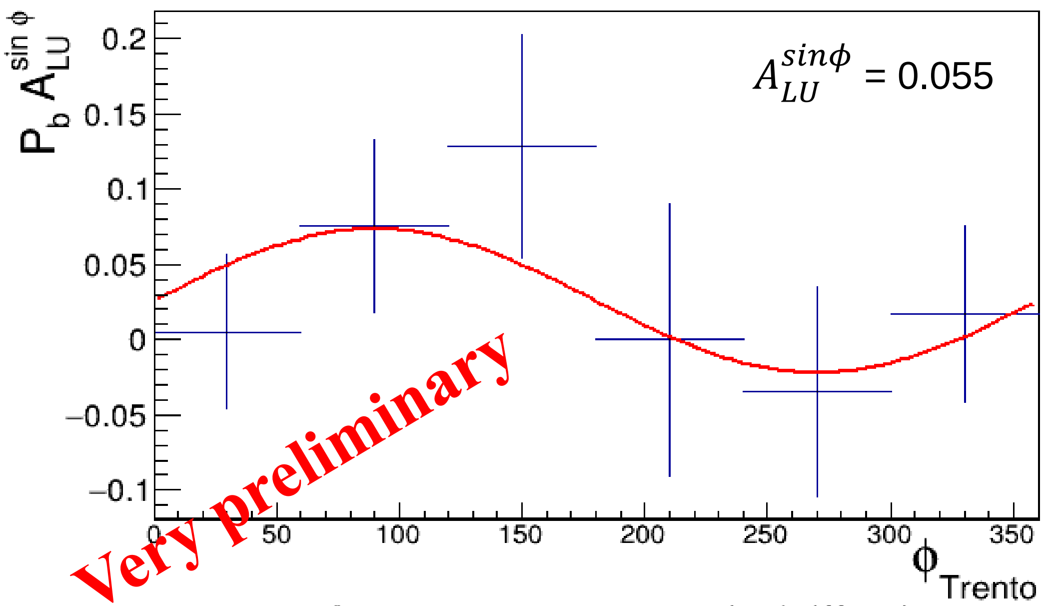


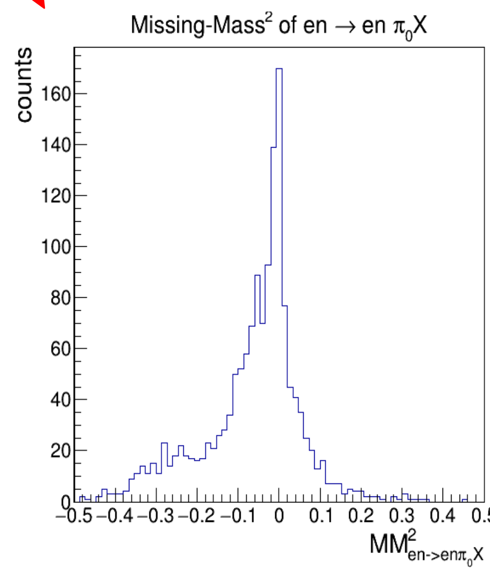
Hard exclusive π_0 production on the neutron

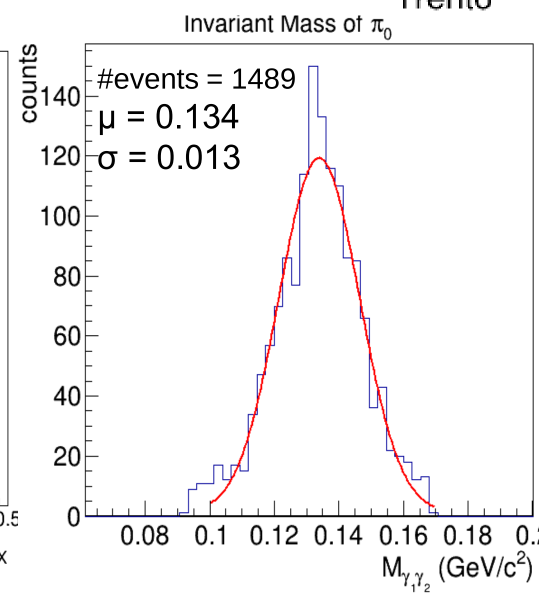
Paul Naidoo & Daria Sokhan – University of Glasgow

- **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
  - $\theta_{e\gamma} > 8^\circ$
  - $\delta\Phi_{Trento} < 5^\circ$
  - $MP_{eD\text{->}e'p'\gamma\gamma} < 0.7$GeV
  - $Q^2 > 1$ 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







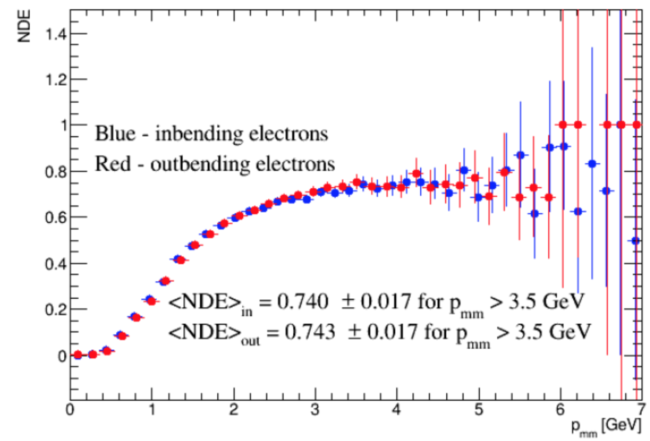
Measuring the neutron detection efficiency (NDE) needed for quasi-elastic e-n $e\,D \rightarrow e'\,n\,(p)$

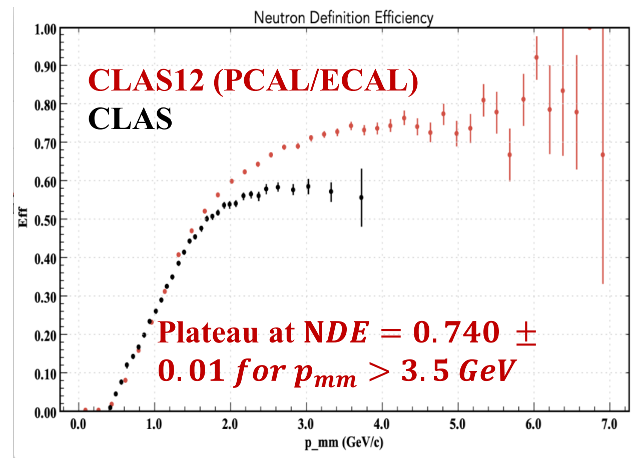
Analysis status:

- 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.

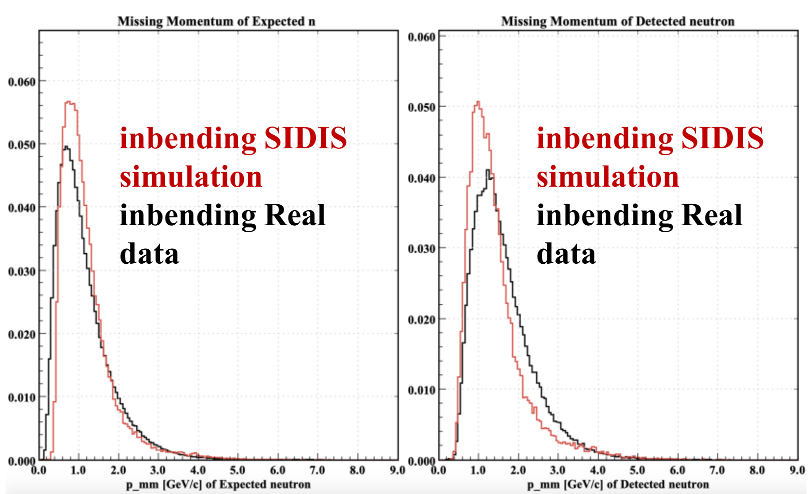
Next steps:

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.

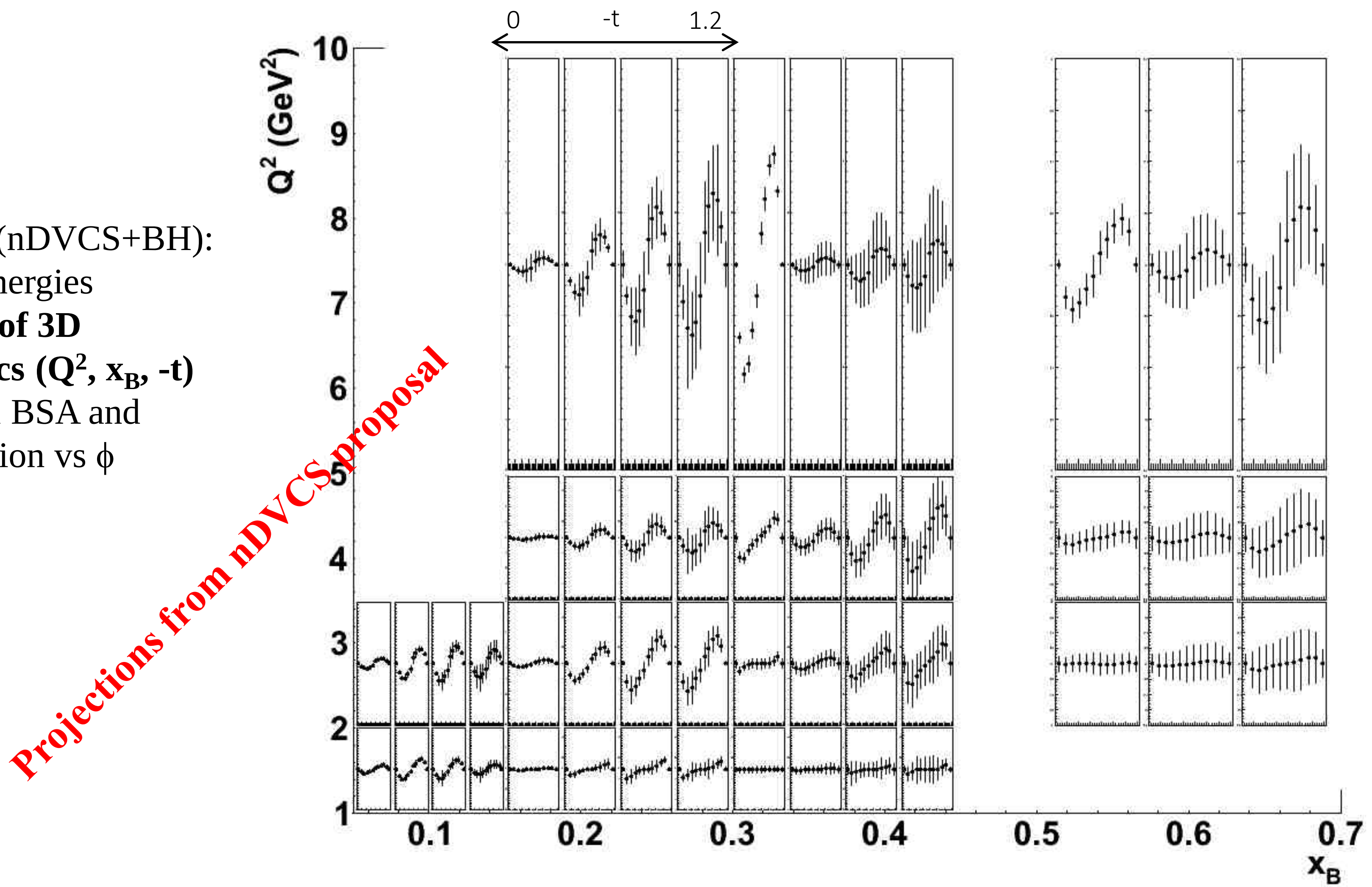


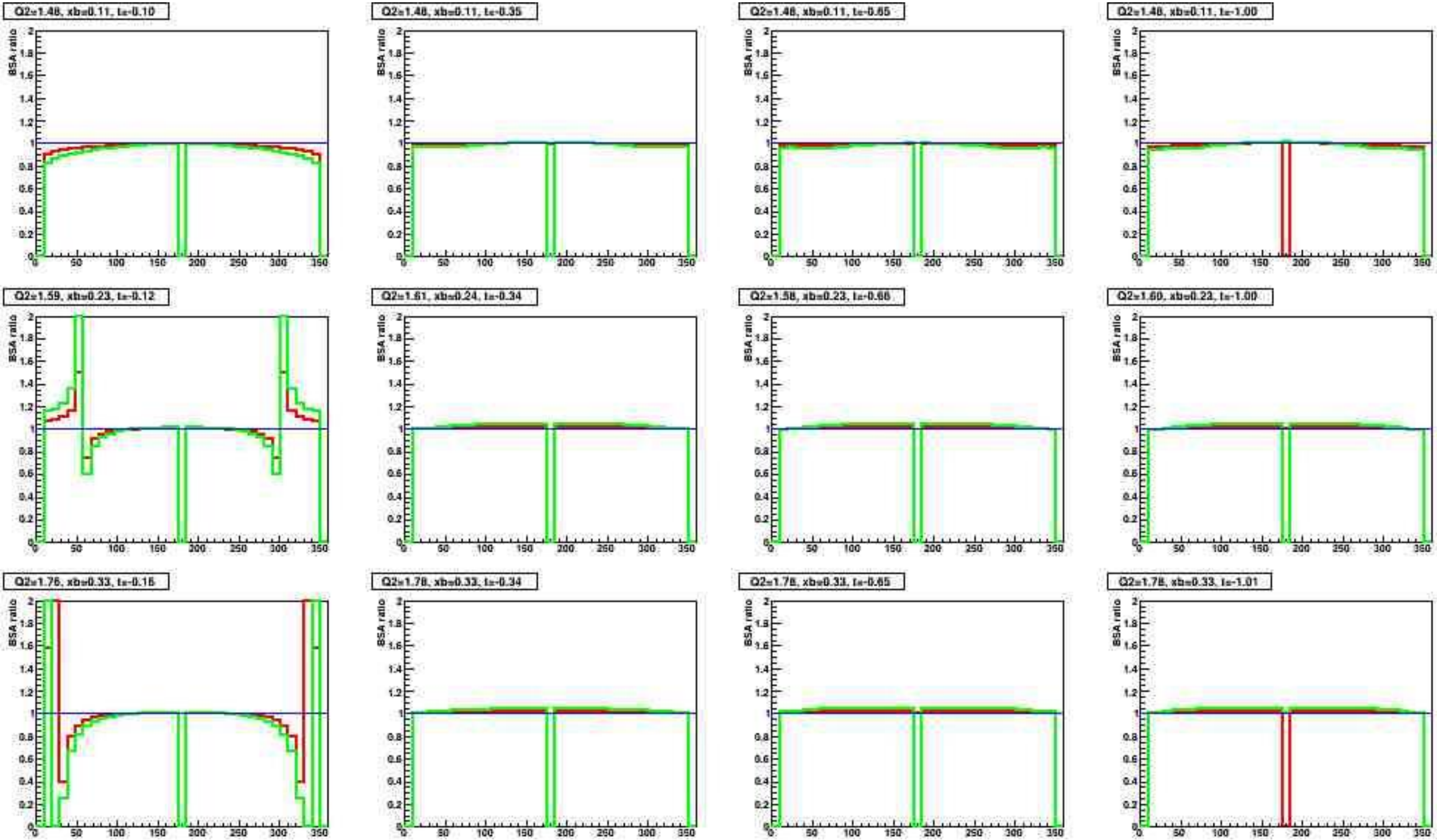
Measurement of BSA for nDVCS-BH with 3 different beam energies

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?

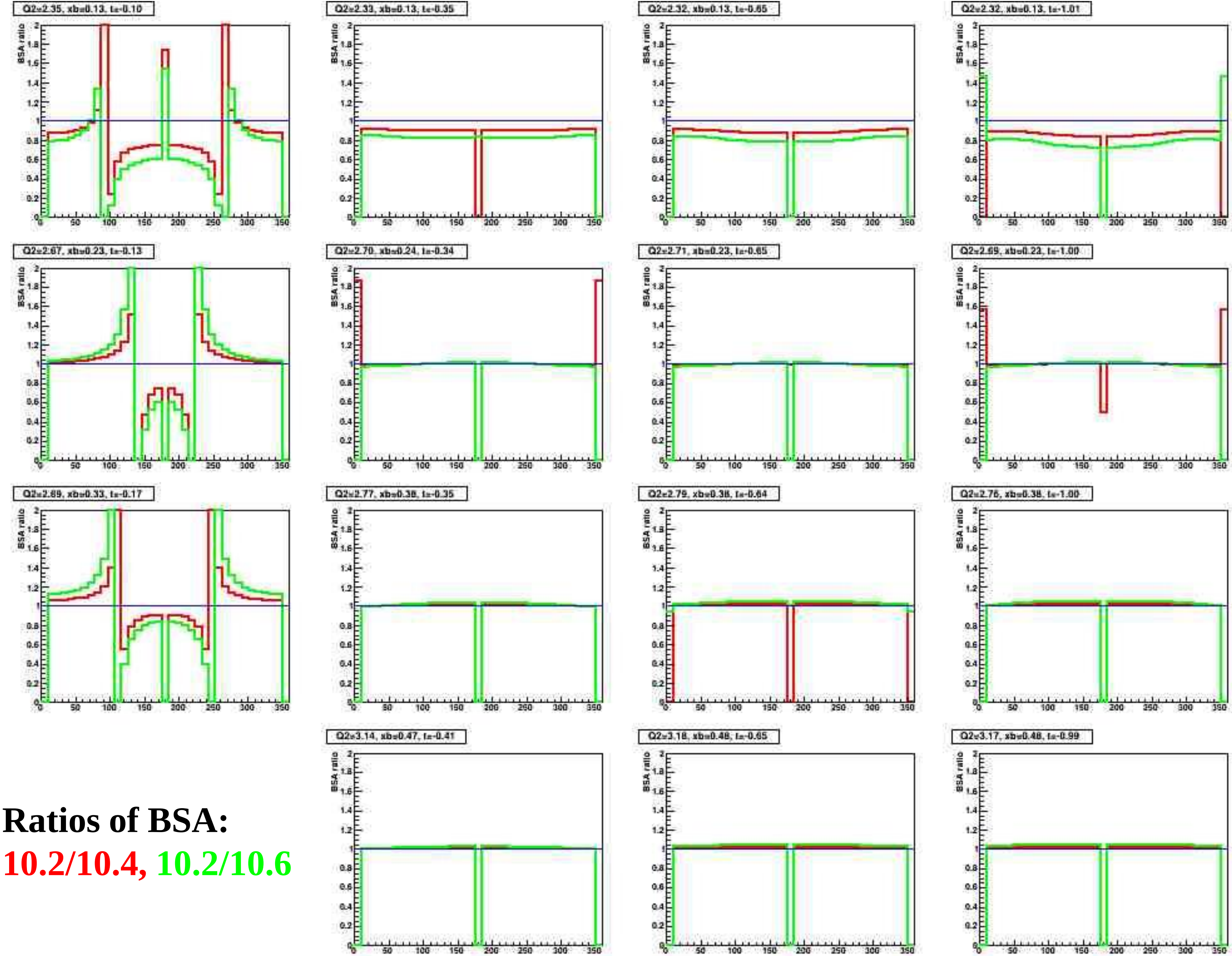
VGG model (nDVCS+BH):

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





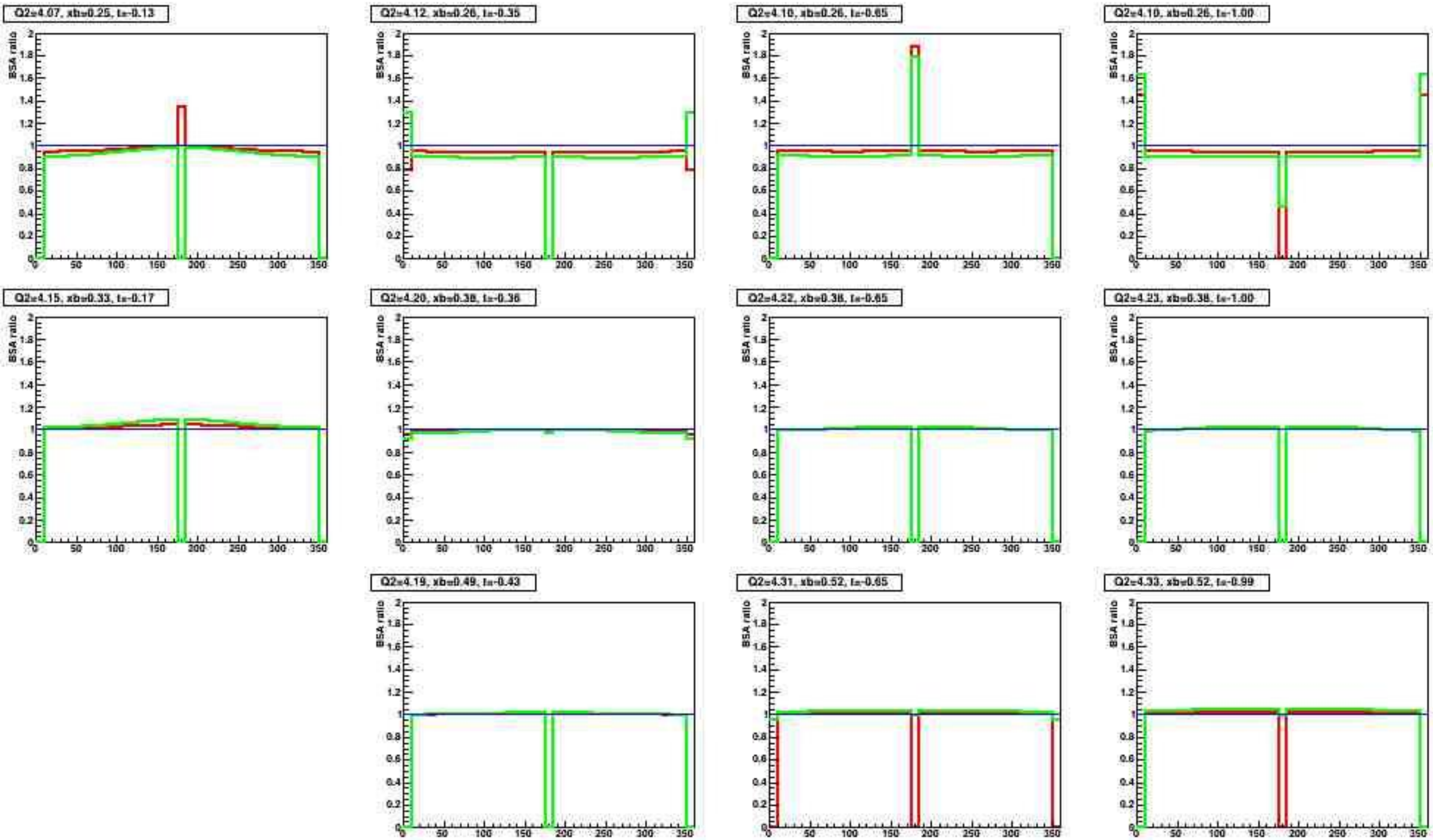
Ratios of BSA: 10.2/10.4, 10.2/10.6



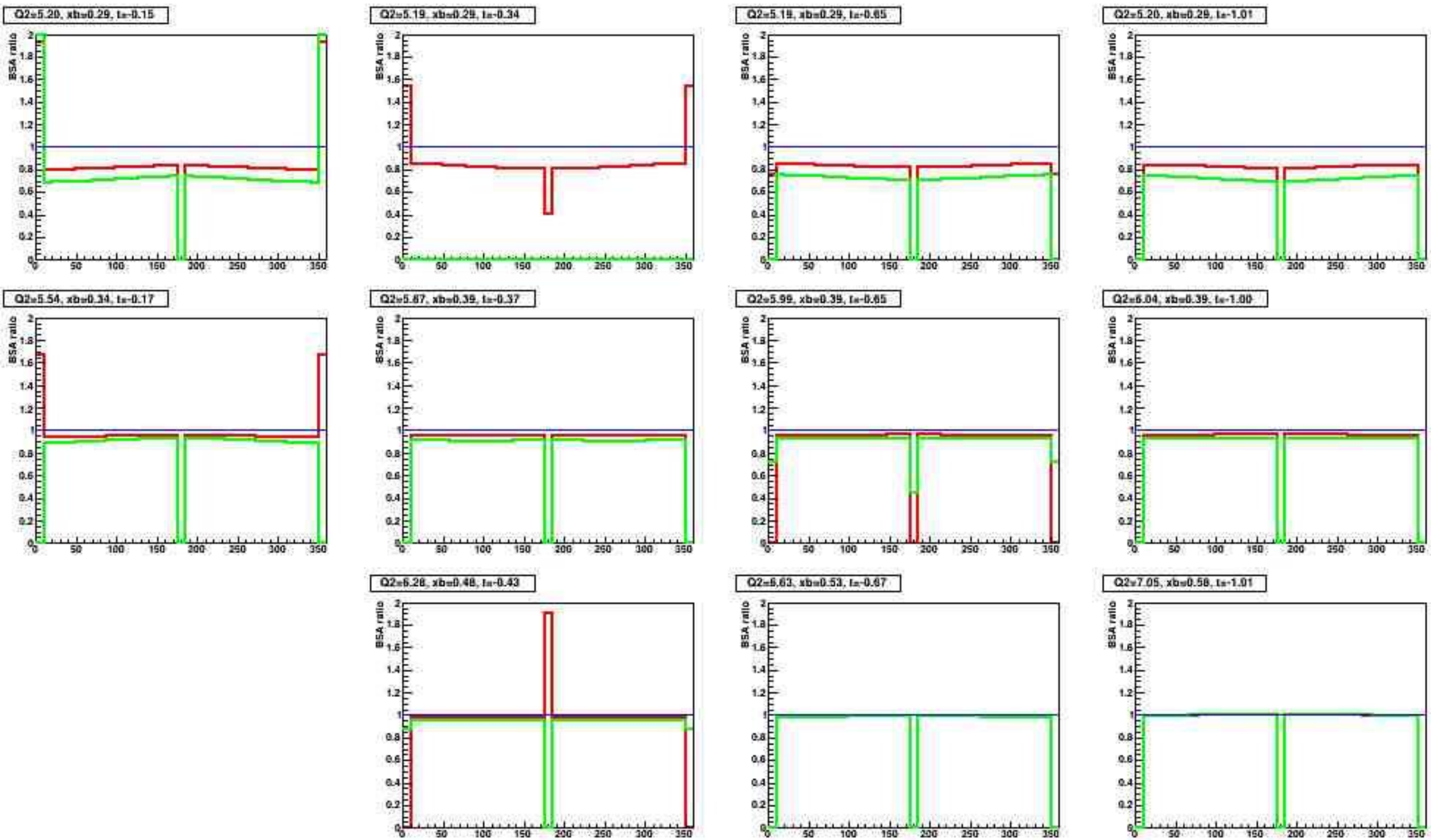
Ratios of BSA:

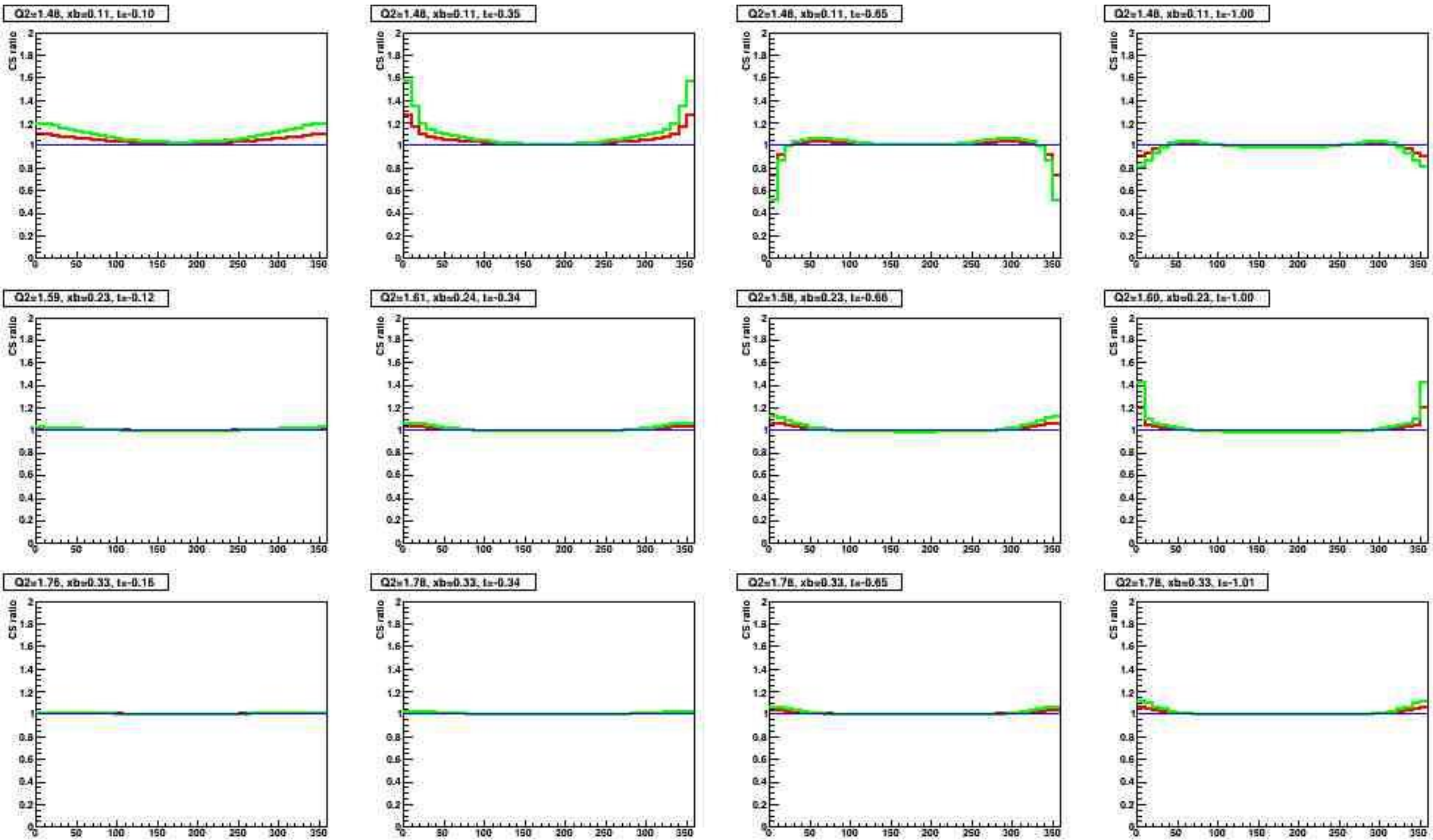
10.2/10.4, 10.2/10.6

Ratios of BSA: 10.2/10.4, 10.2/10.6

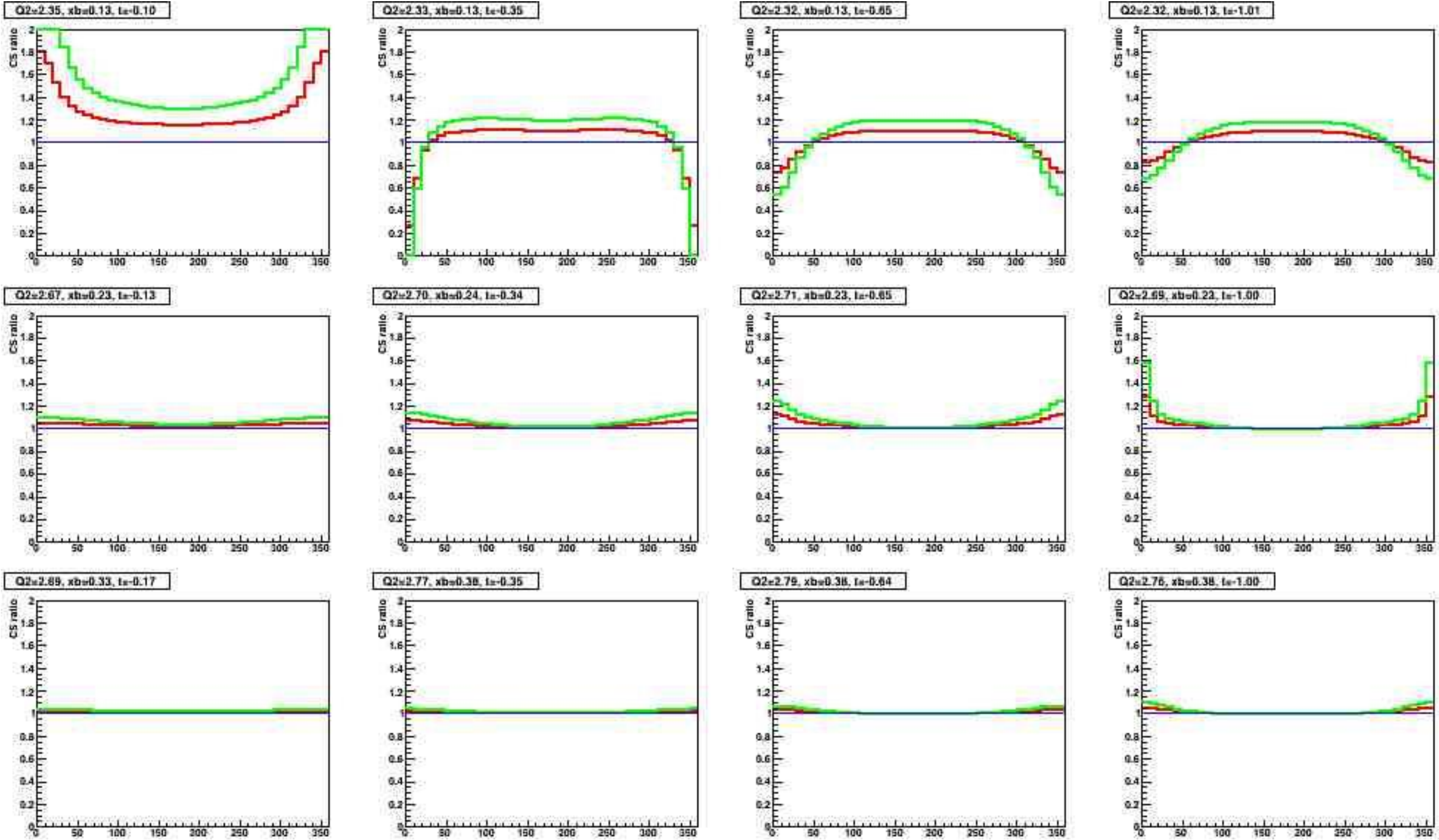


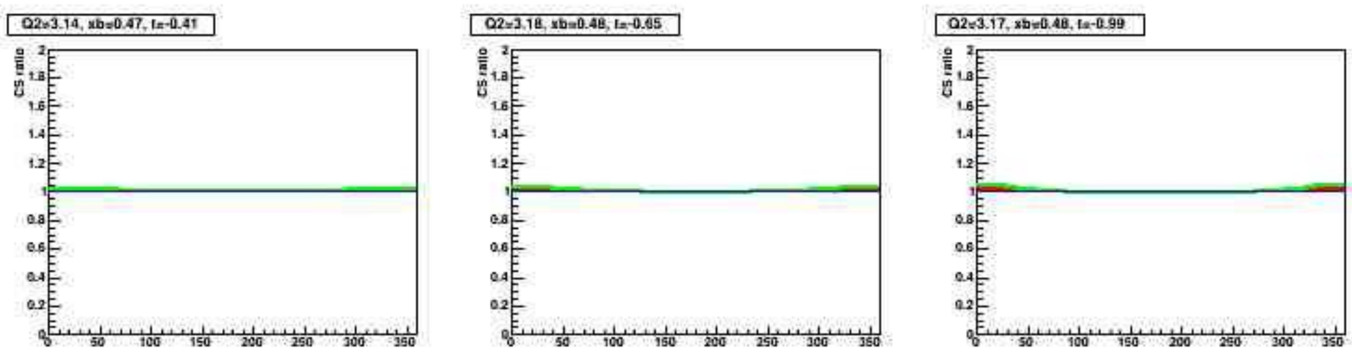
Ratios of BSA: 10.2/10.4, 10.2/10.6





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

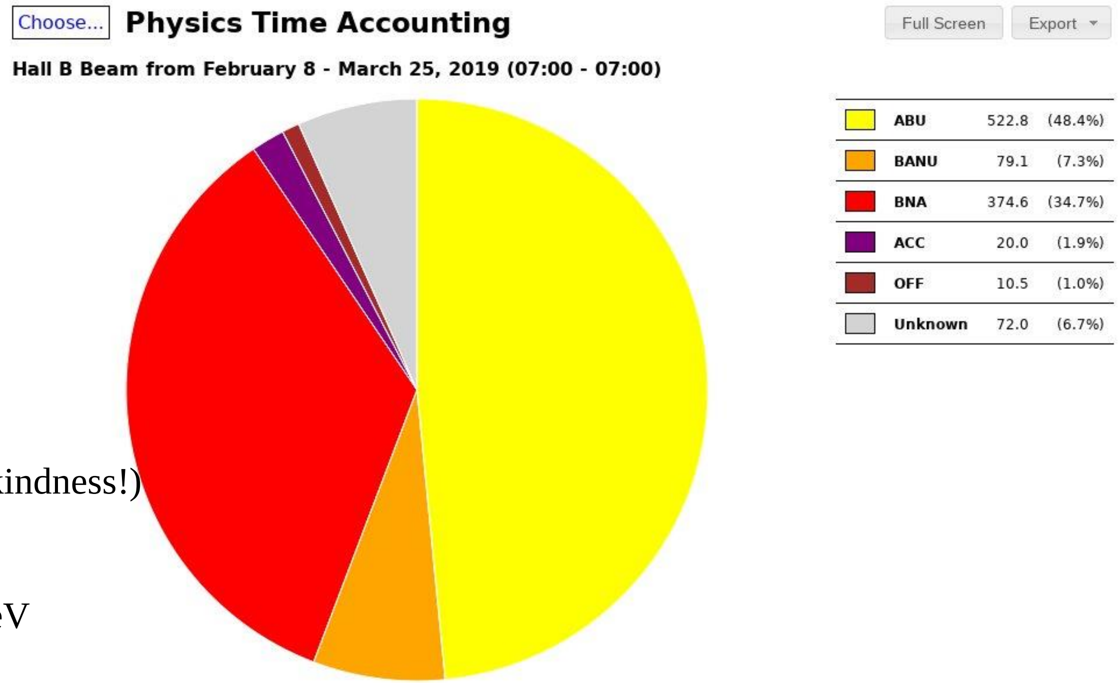
Run Group B spring 2019 run

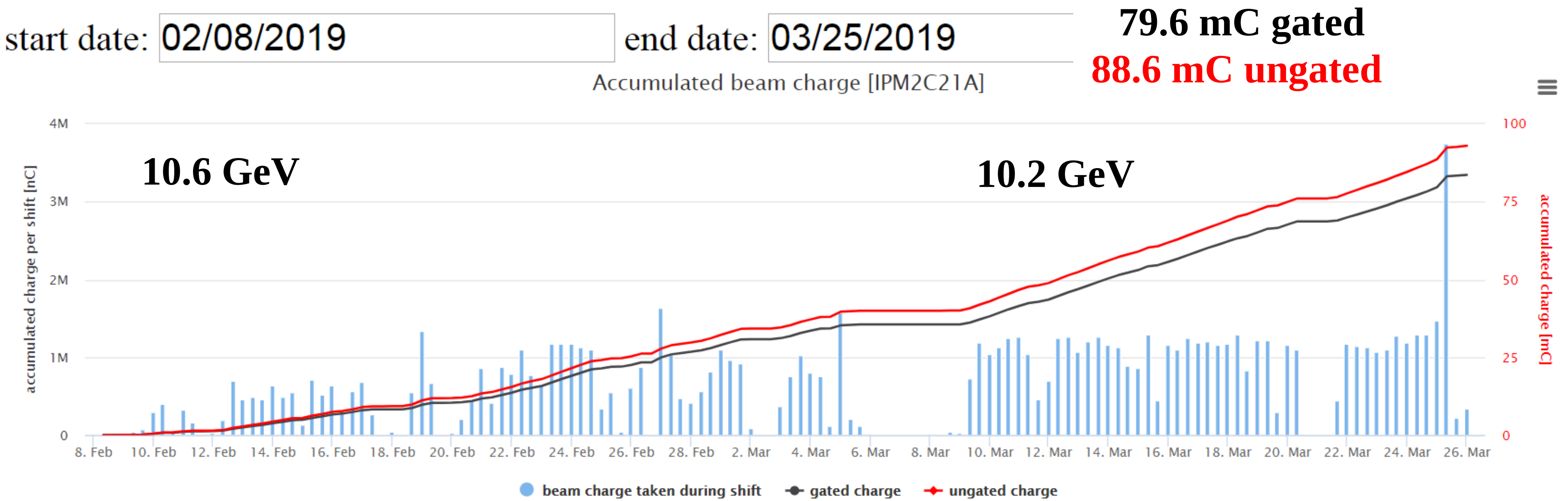
Running conditions:

- **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





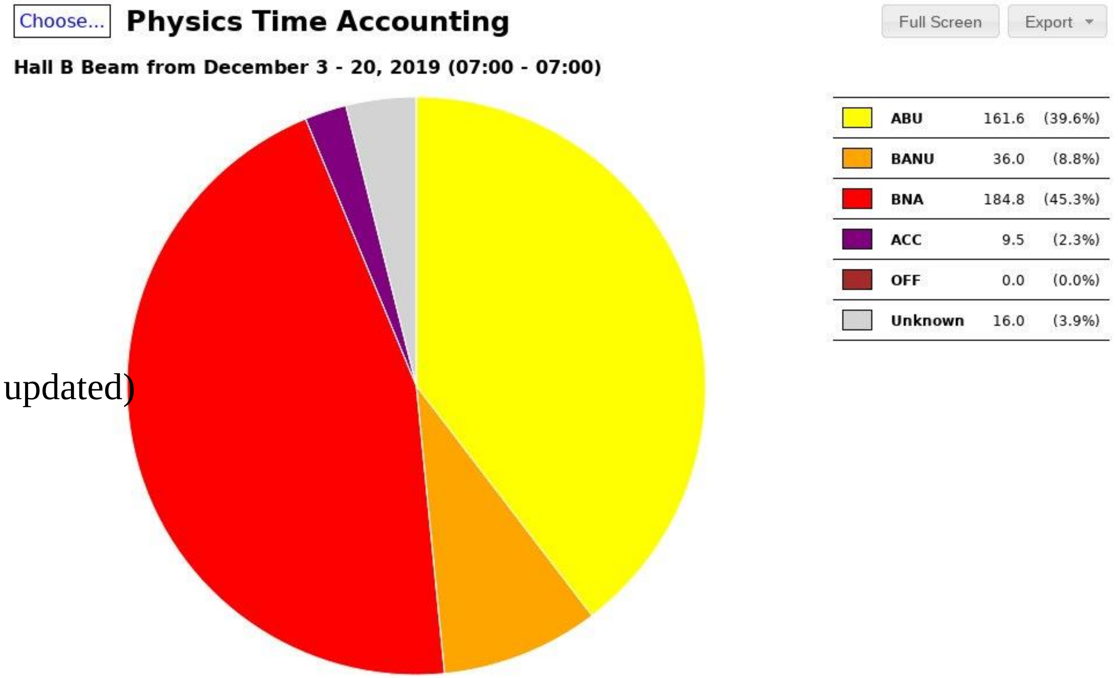
Run Group B fall 2019 run

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

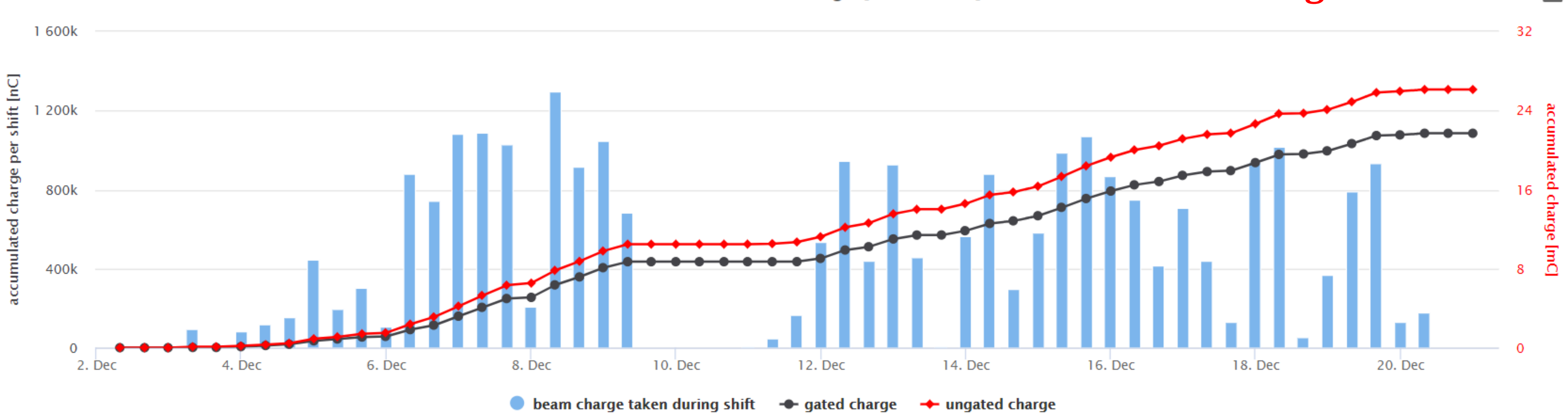


start date: 12/02/2019 end date: 12/20/2019

21.7 mC gated

26.1 mC ungated

Accumulated beam charge [IPM2C21A]



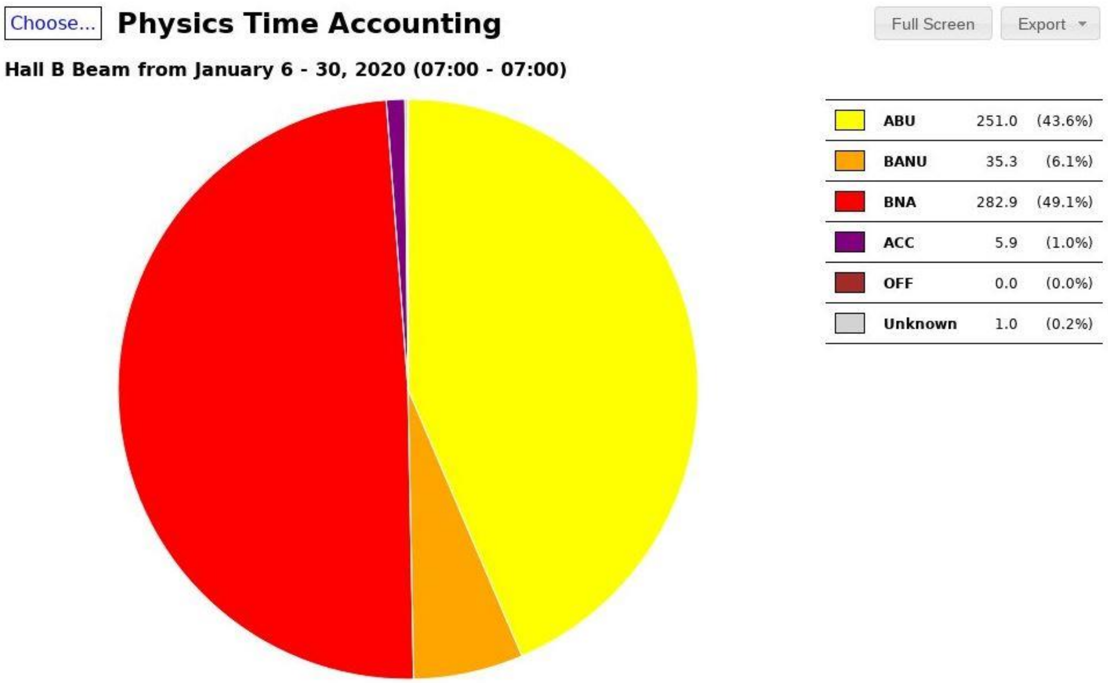
Run Group B winter 2020 run

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