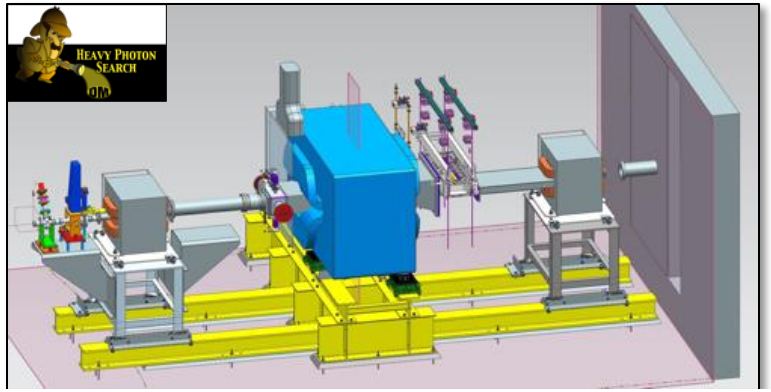
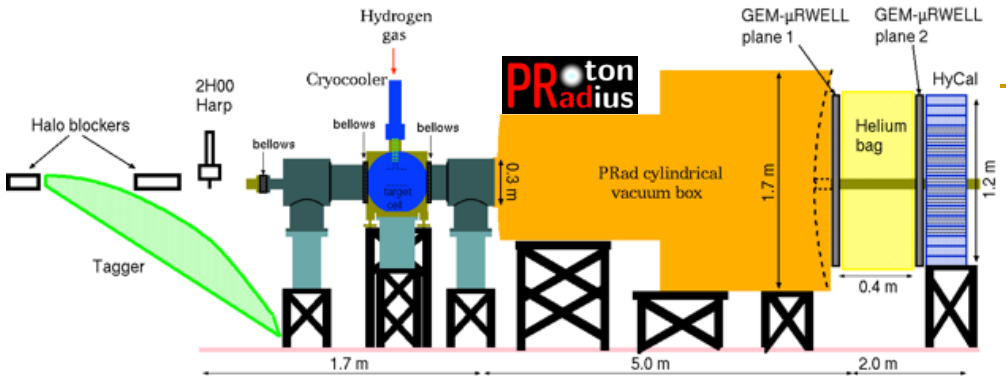
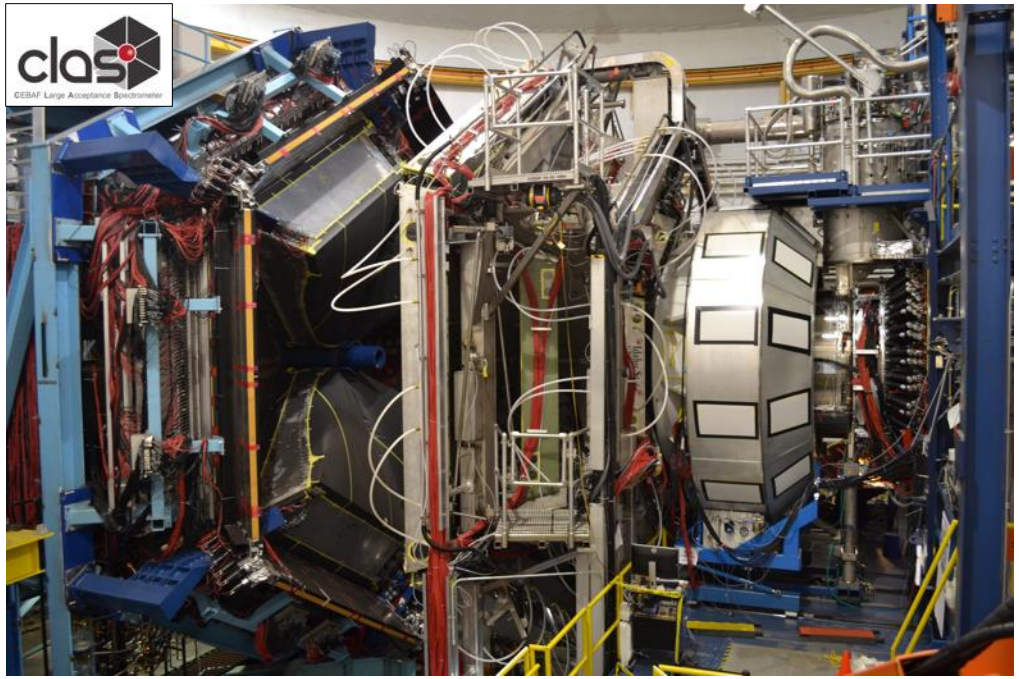
Hall-B Update







S. Stepanyan (JLAB)

HPS Collaboration meeting

June 3, 2025

Overview

- Moving forward with CLAS and CLAS12 publications. Ten papers have been submitted for publication, and half have been published since the last HPS meeting. More analyses are currently in the pipeline, at various stages of review.
- Completed the detector fabrication (ANL/IJCLab) and installation for RG_L (ALERT). We are now running RG-L, with a reconfigured CLAS12 central detector, a 10.67 GeV electron beam, and a 4He gas target.
- Advancing with a high luminosity upgrade for forward tracking. The fabrication of the second large-area μRWELL prototype has begun.
- Continue improving the tracking software and implement the new tracker in the CLAS12 software.
- Other Hall-B collaborations:
  - HPS is preparing the third physics publication on SIMPs and progressing with data calibration of physics runs.
  - PRad is preparing for the second run, which includes a high-precision measurement of proton charge radius and a search for X17 particle.
- Hall B submitted two new proposals and one returning proposal for PAC53, adding three more years to the Hall B queue.
- The Hall-B postdoctoral associate position has been filled. Bhawani Sigh started in February.

Publications

CLAS12

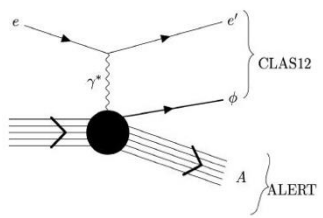
- A. Hobart *et al.*, "First Exclusive Measurement of Deeply Virtual Compton Scattering on the Neutron", Phys. Rev. Lett. 133, 211903 (2024).
- V. Klimenko *et al.*, "Inclusive Electron Scattering in the Resonance Region from a Hydrogen Target with CLAS12", submitted to Phys. Rev. C (2025).
- A. Kripko *et al.*, "Multidimensional Measurements of Beam Single Spin Asymmetries in Semi-Inclusive Deep-Inelastic Charged Kaon Electroproduction off Protons in the Valence Region", submitted to Phys. Rev. Lett. (2025).
- D.S. Carman *et al.,* "Recoil Polarization in K+Y Electroproduction in the Nucleon Resonance Region with CLAS12", submitted to Phys. Rev. C (2025).

CLAS

- S.J. Paul *et al.*, "Dihadron Azimuthal Correlations in Deep-Inelastic Scattering Off Nuclear Targets", Phys. Rev. C 111, 035201 (2025).
- T. Mineeva *et al.*, "Suppression of Neutral Pion Production in Deep-Inelastic Scattering of Nuclei with the CLAS Detector", submitted to Phys. Rev. Lett. (2024)
- L. Clark *et al.*, "Photoproduction of the Σ+ Hyperon Using Linearly Polarized Photons with CLAS", Phys. Rev. C 111, 025204 (2025).
- A. Deur *et al.*, "Measurement of the Nucleon Spin Structure Functions for 0.01 < Q2 < 1 GeV2 Using CLAS", Phys. Rev. C 111, 035202 (2025).
- A.V. Sarantsev *et al.*, "Photoproduction of two Charged Pions off Protons in the Resonance Region", Phys. Rev. C 111, 035203 (2025).
- P. Roy *et al.*, "Measurement of Single- and Double-Polarization Observables in the Photoproduction of π+π- Pairs off the Proton Using CLAS at Jefferson Laboratory", submitted to Phys. Rev. C (2025).

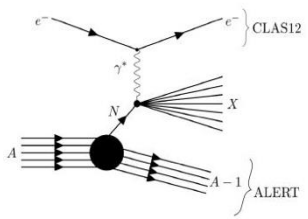
RG-L (ALERT) run in progress

- The aim is to study nuclear and bound nucleon structure using low-energy recoil tagging (^{4}He, 3He, ^{3}H, ^{2}H).
- The recoil detector consists of a hyperbolic drift chamber and a set of scintillator counters (inside the DC gas volume).



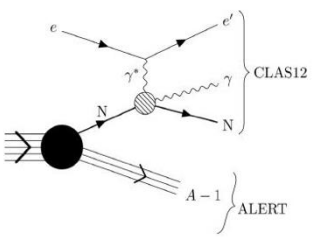
Coherent Processes on ^{4}He

- ^{4}He(e,e'γ)^{4}He
- ^{4}He(e,e'ϕ)^{4}He



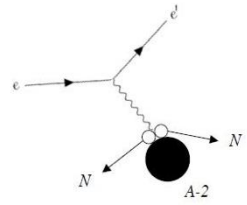
DIS on ^{4}He and ^{2}H: Tagged EMC Effect

- ^{4}He(e,e'^{3}H)X
- ^{4}He(e,e'^{3}He)X
- ^{2}H(e,e'p)X



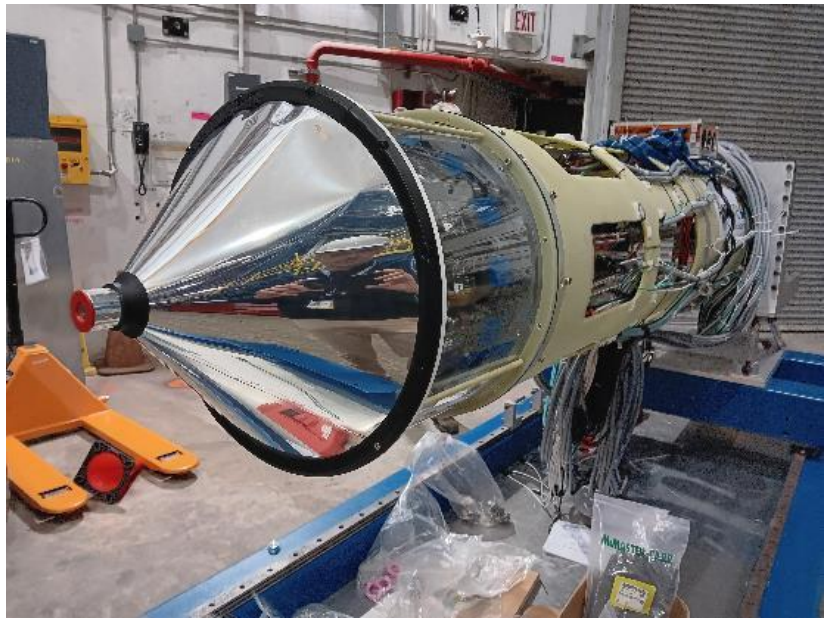
Incoherent Processes on ^{4}He and ^{2}H

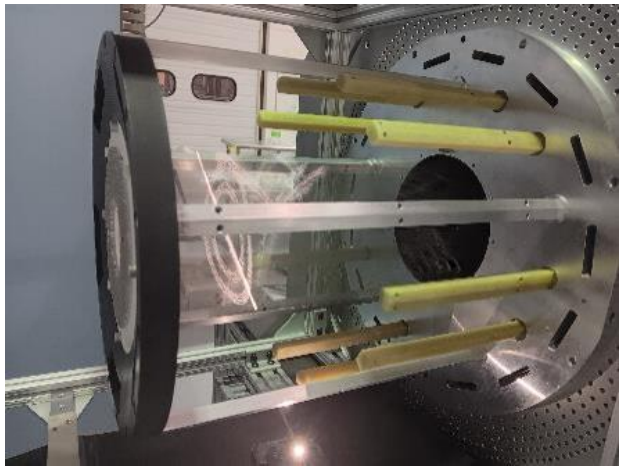
- ^{4}He(e,e'γp^{3}H)
- ^{4}He(e,e'γ^3He)n
- ^{2}H(e,e'γp)n

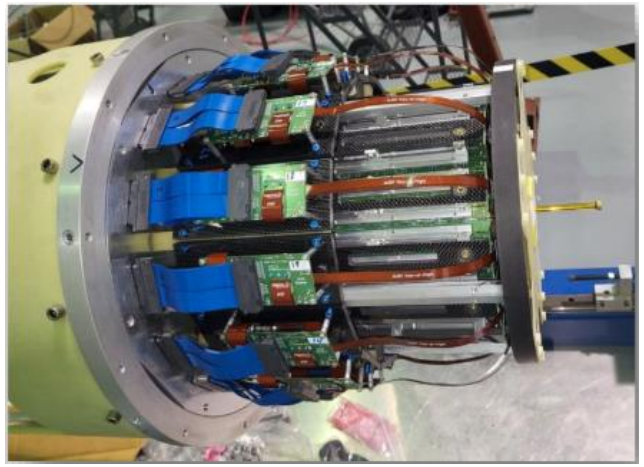


Short Range Correlations on ^{4}He

- ^{4}He(e,e'pd)n
- ^{4}He(e,e't)p
- ^{4}He(e,e'p)

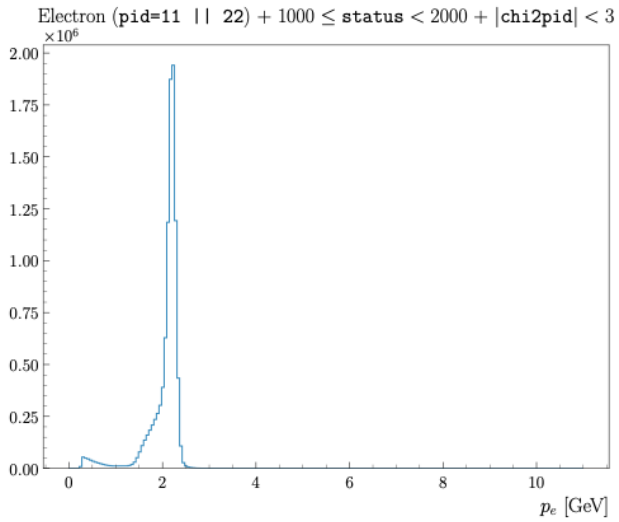


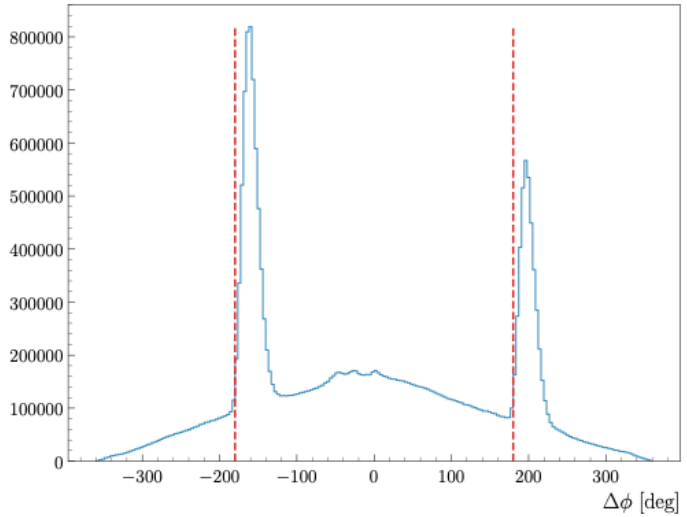


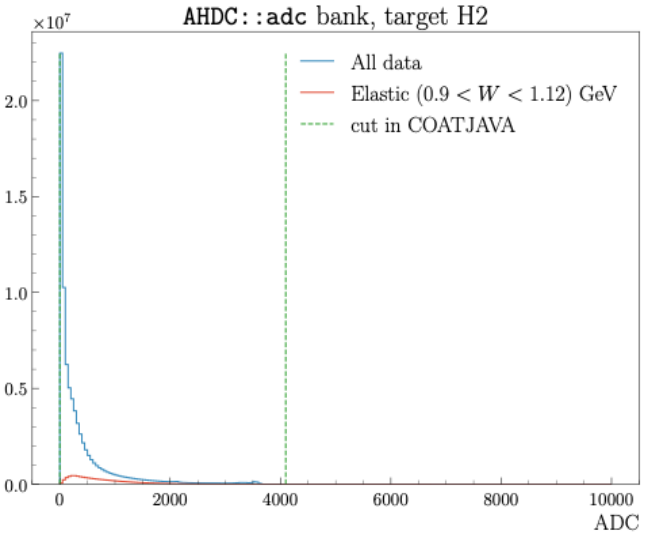


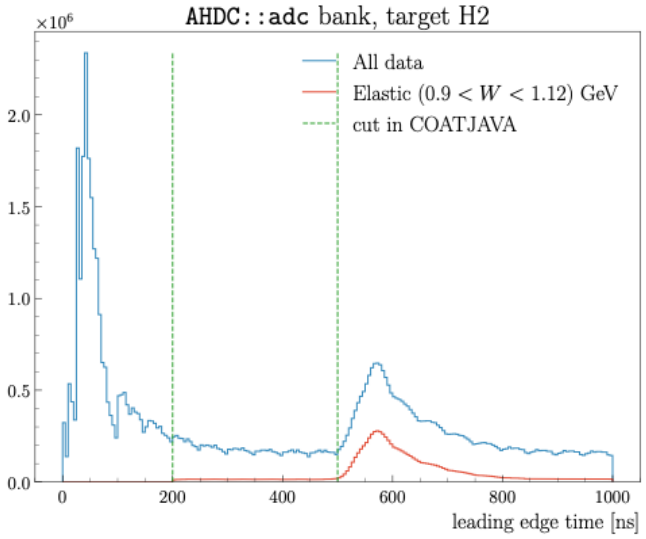
ALERT data: first look on elastic scattering

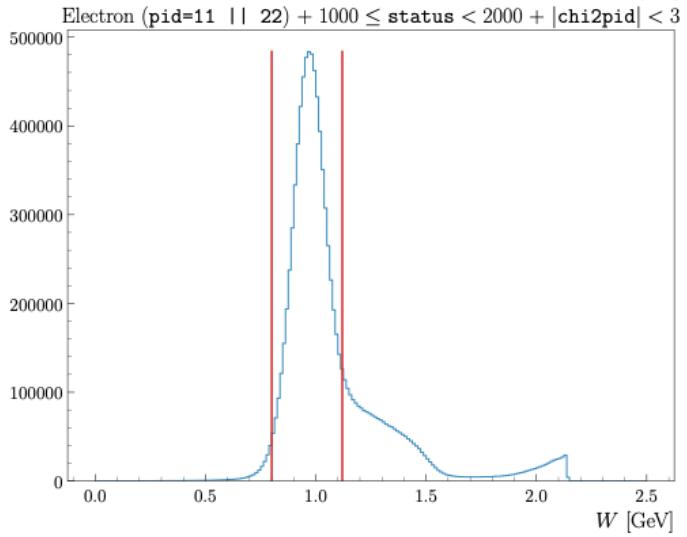
- Low-energy run to calibrate the drift chamber
  - The target is H_2,
  - The beam energy E=2.23 GeV
- A scattered electron is identified in the CLAS12 forward detector
- Hit-based tracks in HADC correlated with the electron in the azimuthal angle.





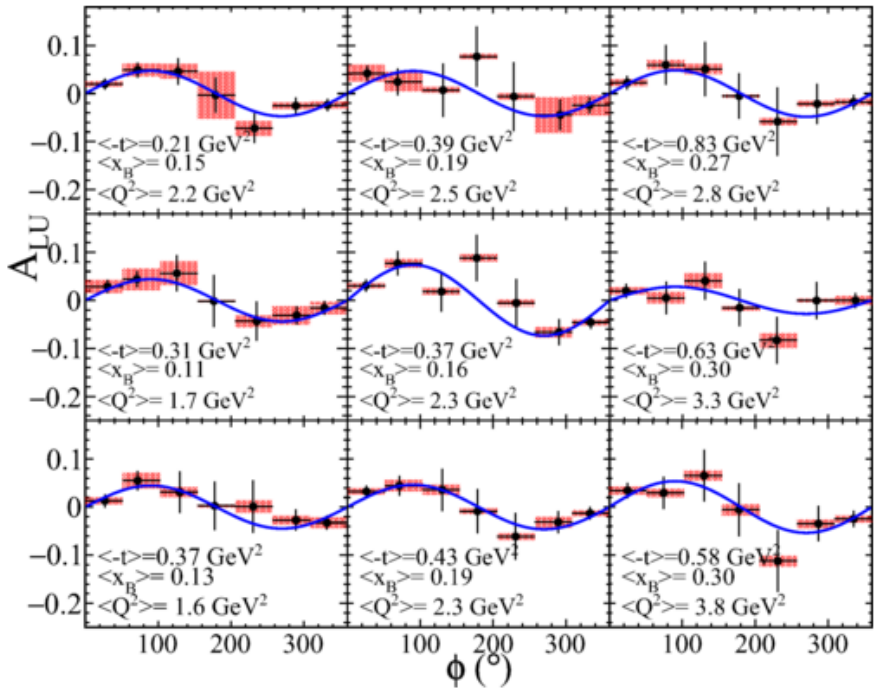


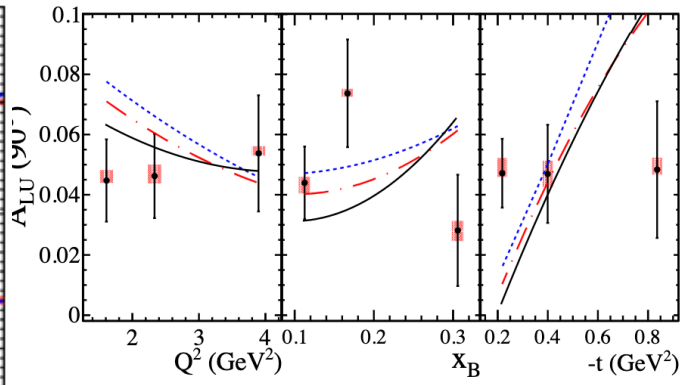




Publication highlights: neutron DVCS

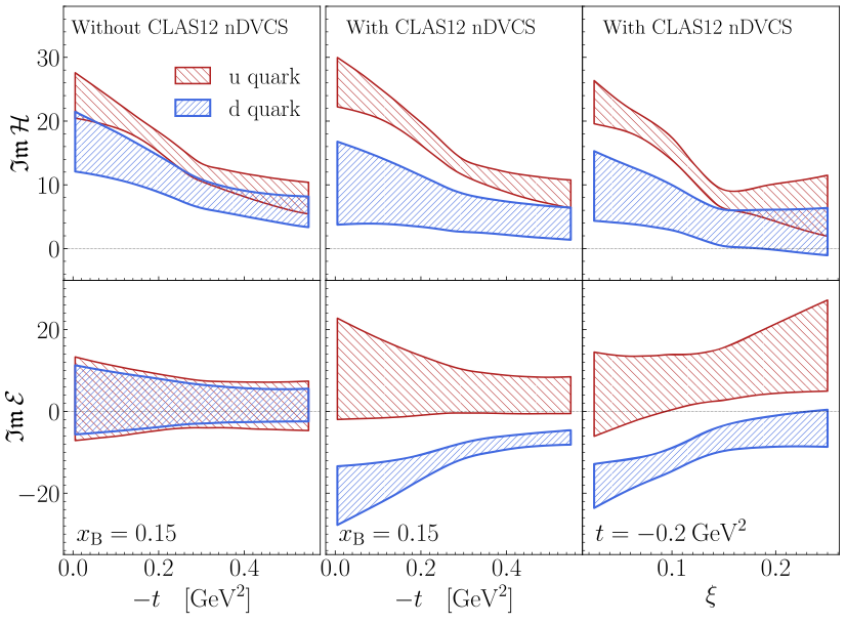
- The Beam Spin Asymmetry (BSA) of neutron-DVCS (nDVCS) from a deuterium target, $\vec{e}d \rightarrow e'n\gamma(p)$, measured for the first time in the exclusive final state with the detection of the recoil neutron.
- These measurements provide access to one of the lesser-known GPD *E,* an essential ingredient in Ji's spin sum rule.
- These new CLAS12 nDVCS data allow for the flavor separation of $\Im\mathrm{m}\mathcal{H}$ and $\Im\mathrm{m}\mathcal{E}$ Compton form factors.





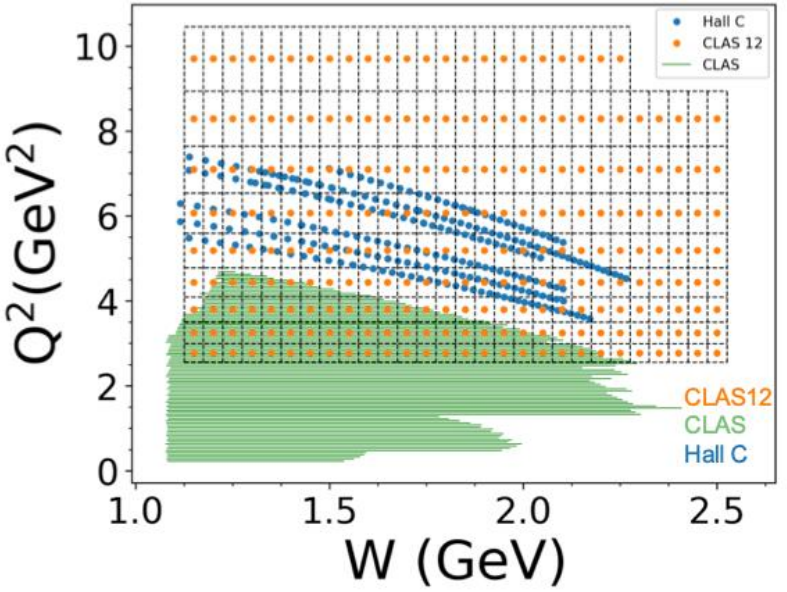
Fits to the Q^2, x_B, and t dependencies of $A_{LU}(90^o)$ with the VGG model. The best fits yielded:

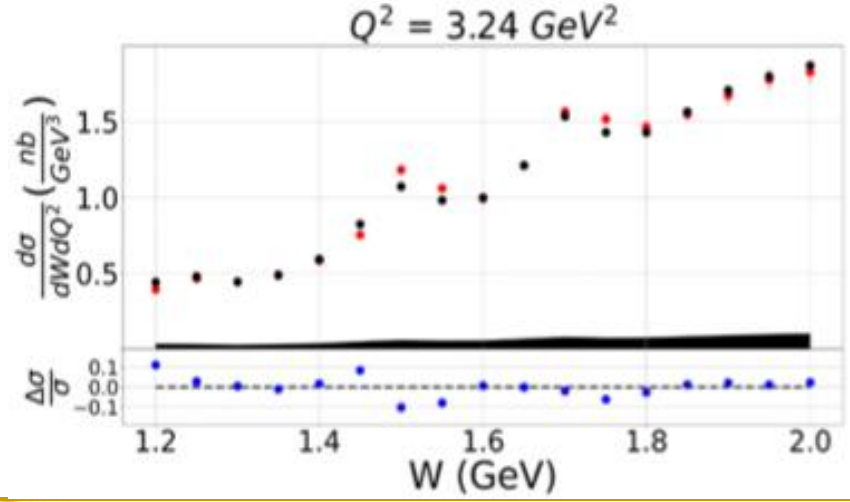
$$\mathrm{J}_u = 0.35, \mathrm{J}_d = 0.05,$$
$$\mathrm{J}_u = -0.2, \mathrm{J}_d = 0.15$$
$$\mathrm{J}_u = -0.45, \mathrm{J}_d = 0.2$$

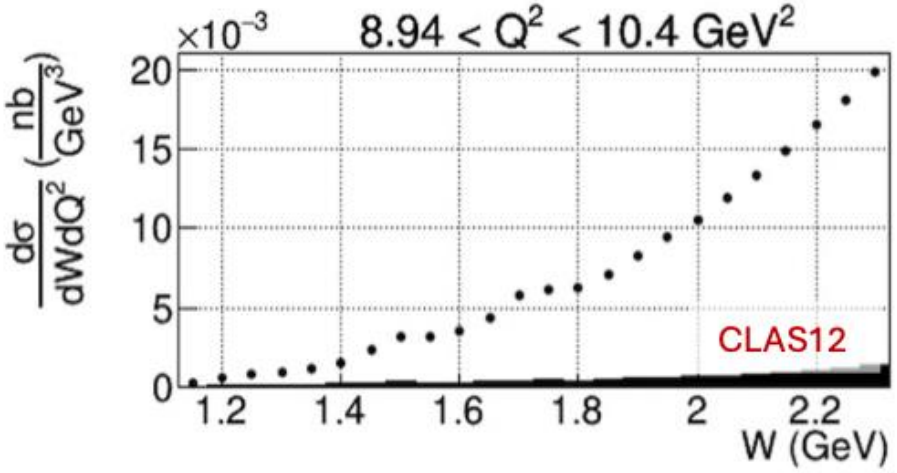


Publication highlights: Inclusive electron scattering cross-sections

- First absolute cross-section measurement from CLAS12. Extend available data from CLAS and Hall C to higher Q^2 and W ranges.
- This result opens up promising opportunities for exploring the ground state nucleon PDFs at large x in the resonance region, with the resonant contributions estimated from experimental data.
- The broad coverage over Q2 allows for exploration of the evolution of the partonic structure of the nucleon within the range of distances where the transition from the strongly coupled to perturbative QCD regimes is expected.

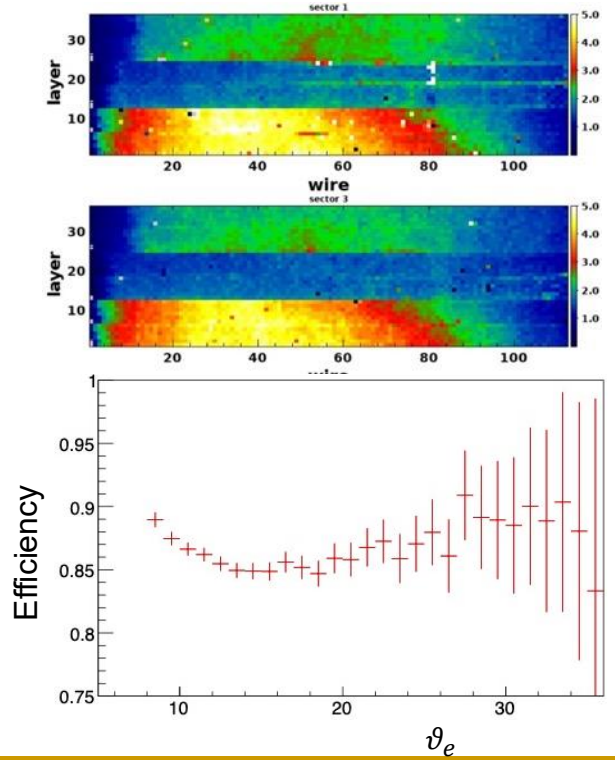


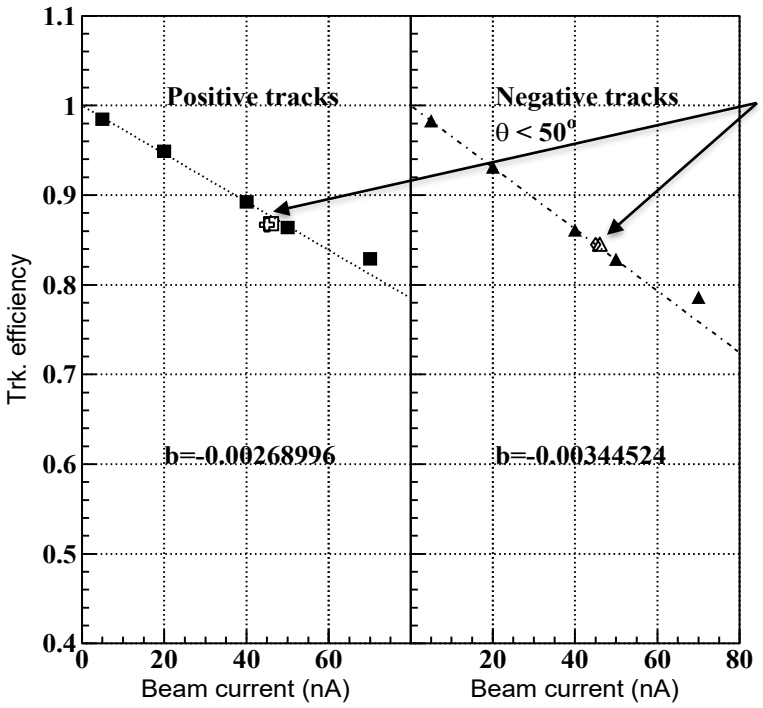




CLAS12 luminosity upgrade, $L \approx 2 \times 10^{35} cm^{-2} sec^{-1}$

- Explore options to enhance the CLAS12 data collection performance via luminosity increase and DAQ optimization. ***This could be through hardware e.g., Region 1 DC replacements with GEM detectors; through software developments e.g., optimized track-finding making use of machine learning in high-rate environments***; and through enhancing L3 capabilities e.g., development of new and faster FADCs in combination with a trigger-less DAQ, streamed readout with event recording based on a Level-3 trigger algorithm.



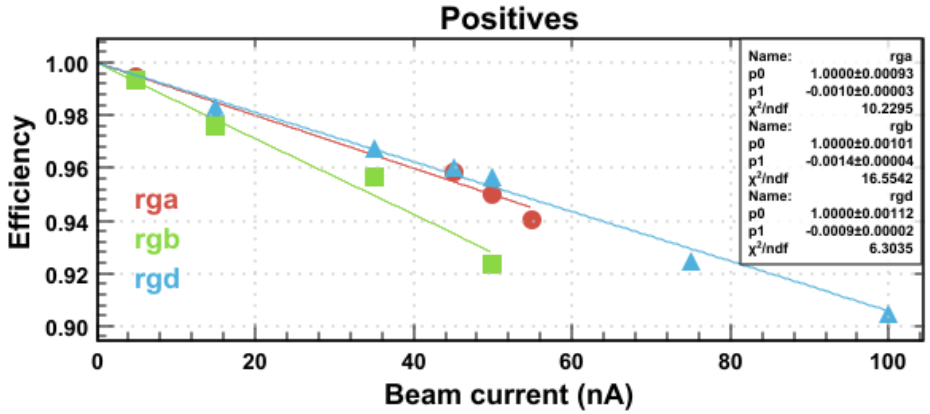


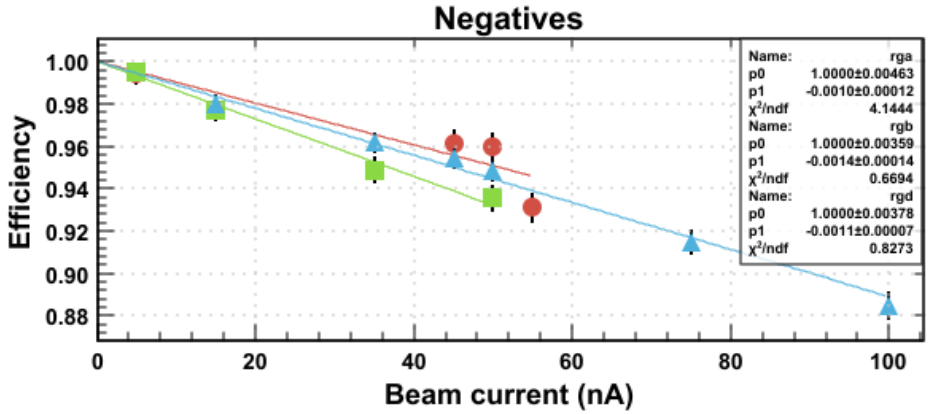
5 nA data merged with a beam background from 40 nA random trigger data.

$$Trk.eff = \frac{N_{eh}(I)}{N_e(I)}$$

Current state of software improvements

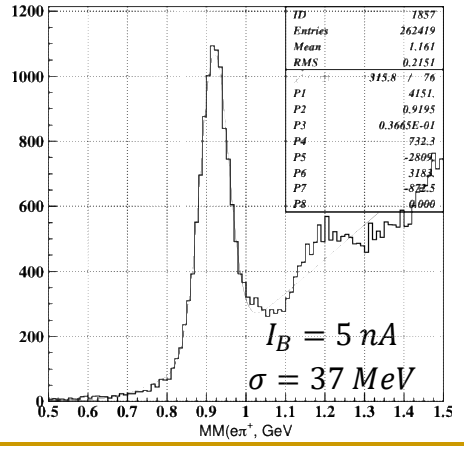
- Multiple steps to improve forward tracking efficiency:
  - AI-assisted tracking – trained to group clusters into track;
  - De-noising – filter out noise (background) hits;
  - DAF – iteratively weighting of hits with Kalman filter
  - Improved clustering and added conventional track finding

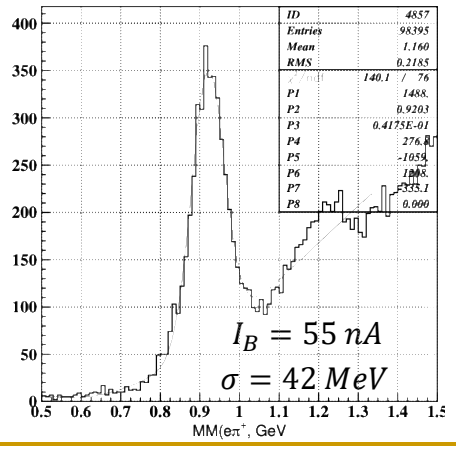


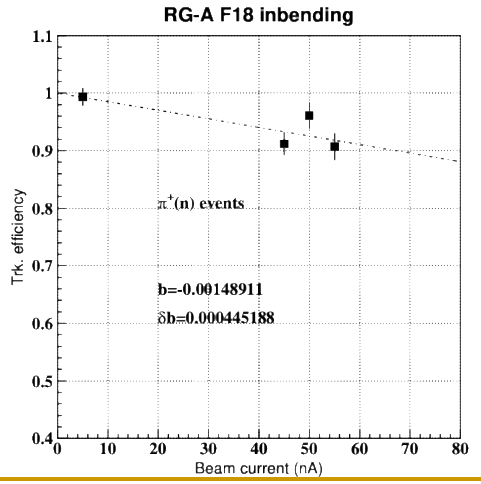


- Track finding nearly achieved the goal of Trk.eff=1-0.001 × I(nA). However, the quality of track parameters, namely momentum and vertex resolutions, suffers from the lost hits in DC.

$$ep \rightarrow e'\pi^+(X)$$

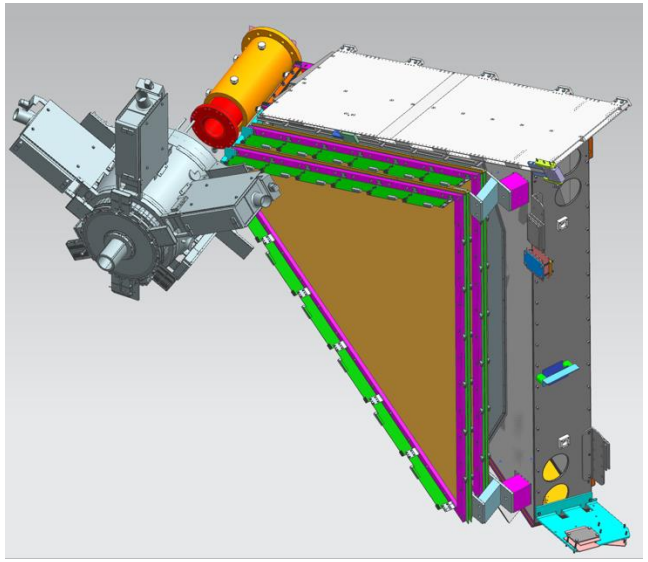


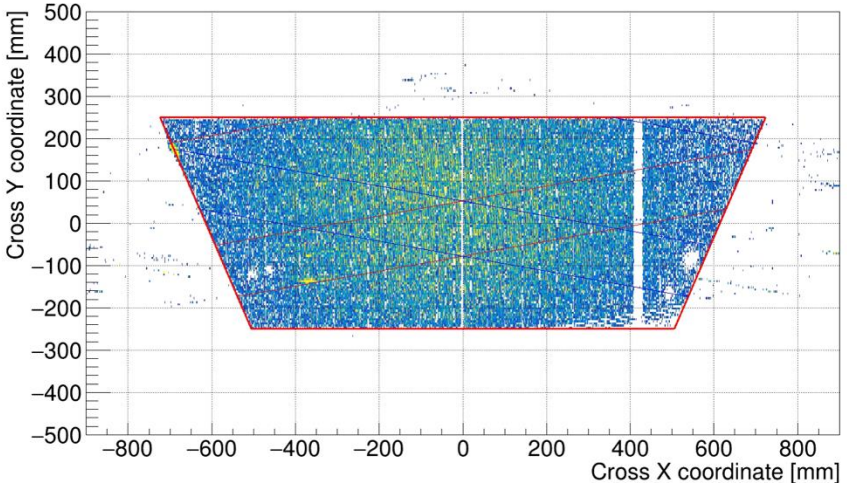


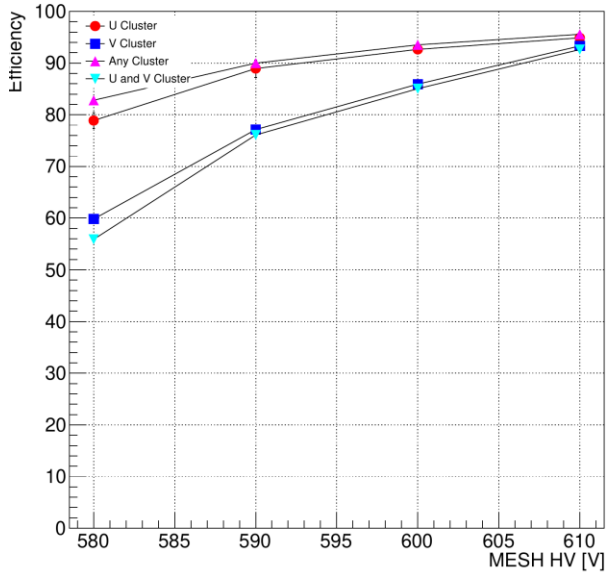


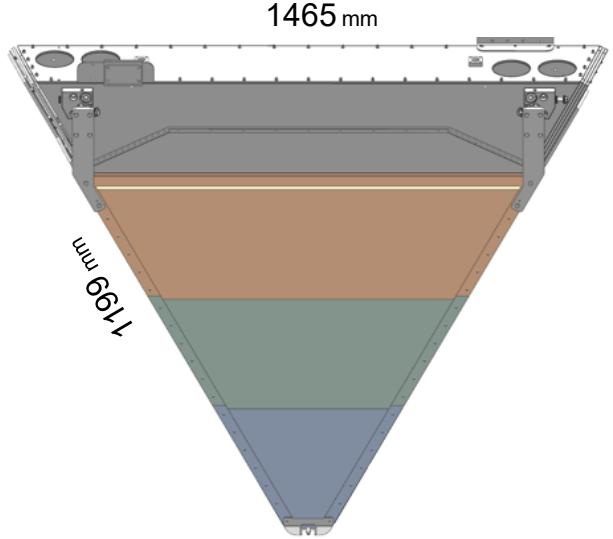
Upgrading the forward tracking system

- The idea is to add fast-tracking detectors in front of CLAS12 R1 DC.
- The μRWELL technology is chosen due to its low material budget, ease of construction, and the absence of support structures in the active volume of the detector.
- The first prototype of the largest segment of the envisioned detector was built with a capacitive sharing readout.
- Unfortunately, the capacitive sharing option did not work for such a long strip readout. Achieving the efficiency plateau is only possible at very high HV, where the detector's operation becomes somewhat unstable.



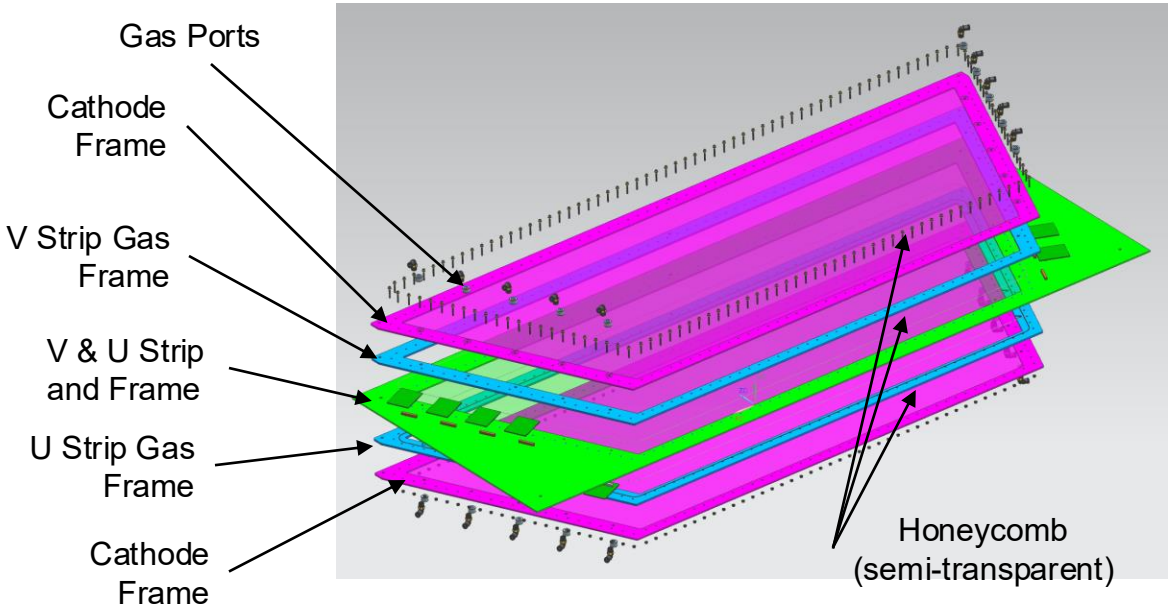






The next step in the CLAS12 mRWELL project

- The new design, the 2x1D detector, aims to achieve high efficiency at lower voltages and stable operation.
- This design will add a layer of honeycomb (less than 200 μm Kapton) to the total material budget.
- μRWELL PCB design changes include the option to disconnect individual HV segments.
- The two μRWELL PCBs are identical.
- We expect to receive frames and PCBs by the end of June. The assembly of the detector will take place at JLAB (if the clean room is ready) or at UVA.

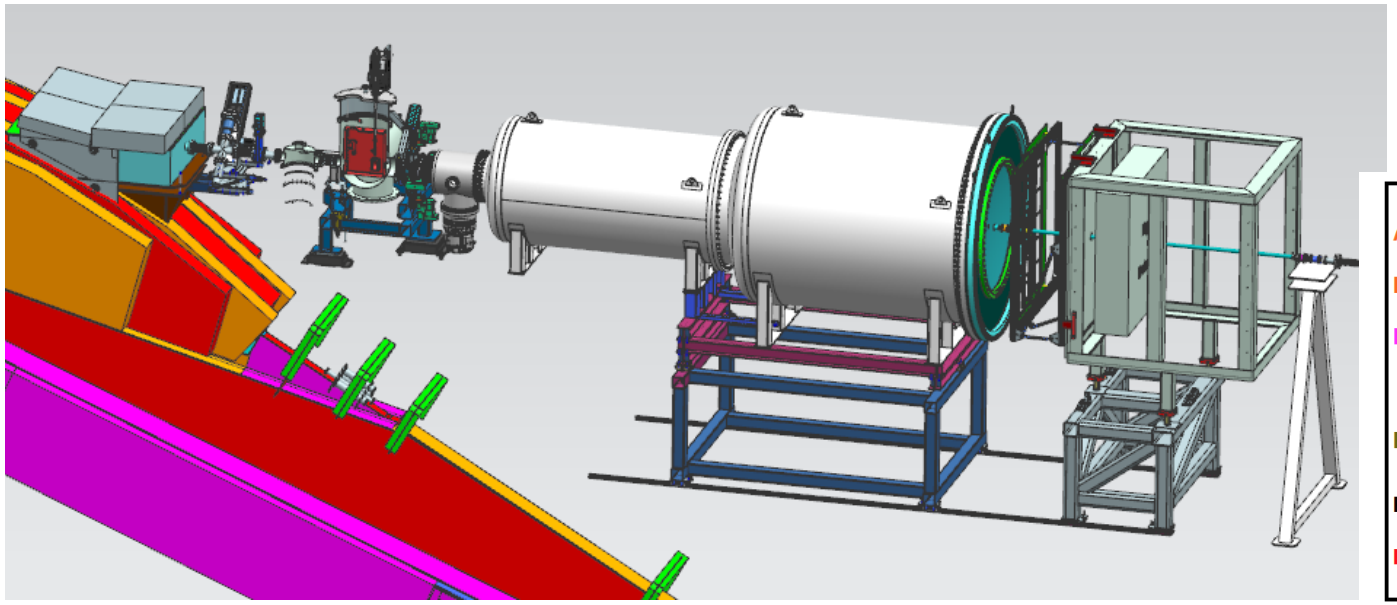


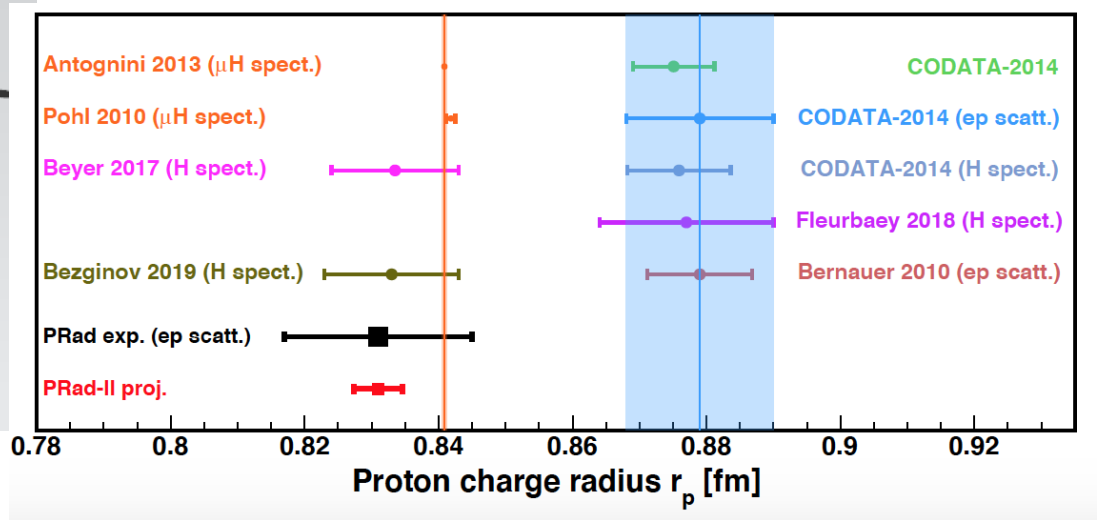
- A preliminary design concept for the readout boards uses VMM3 chips. After a successful test of the current VMM3 board, full design and fabrication of the test modules can move forward.

Upcoming run, PRad

Elastic scattering on gas-jet hydrogen target at 0.5 to 7 degrees, covering region of Q^2 from 2×10^{-5} to 6×10^{-2} GeV^2

- 6 days with 0.7 GeV, 20nA
- 6 days with 2.1 GeV 150nA
- 12 days with 3.5 GeV, 150nA



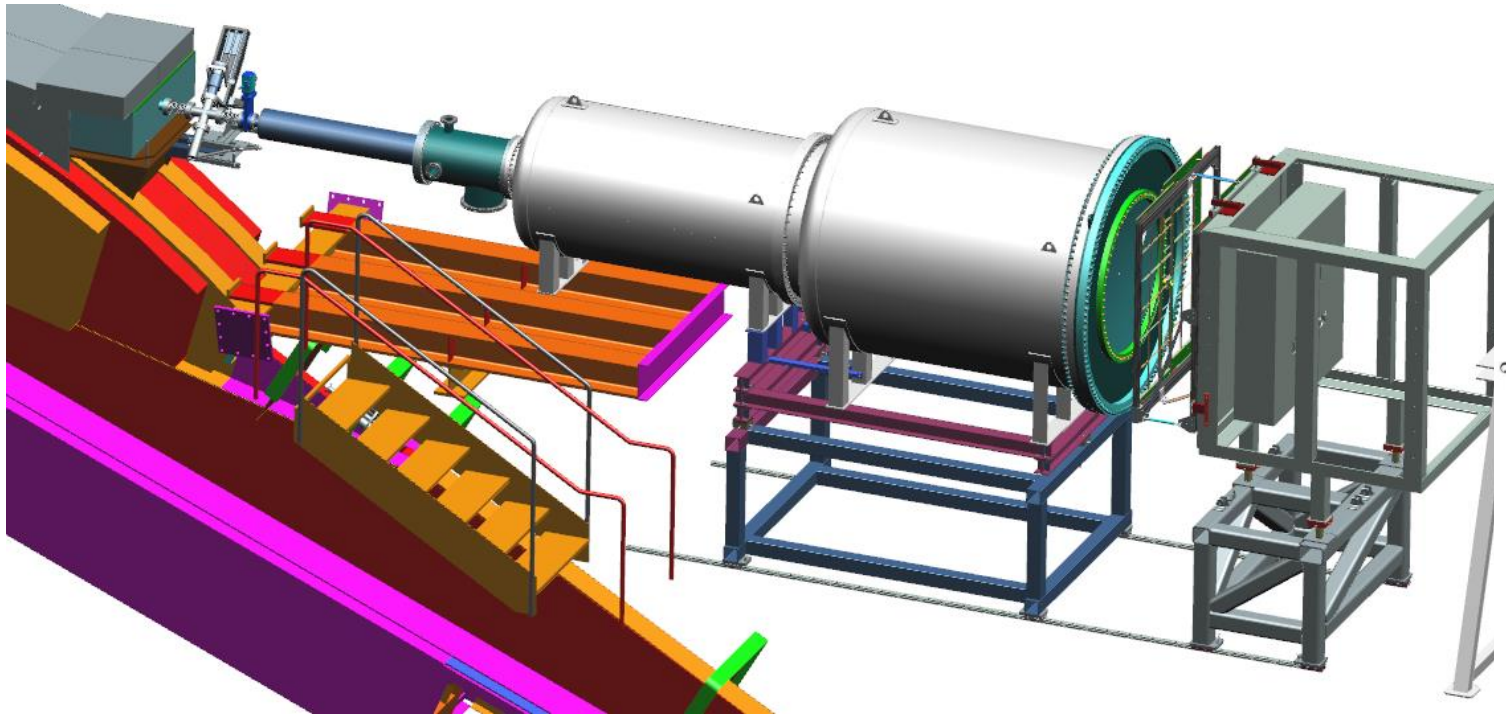


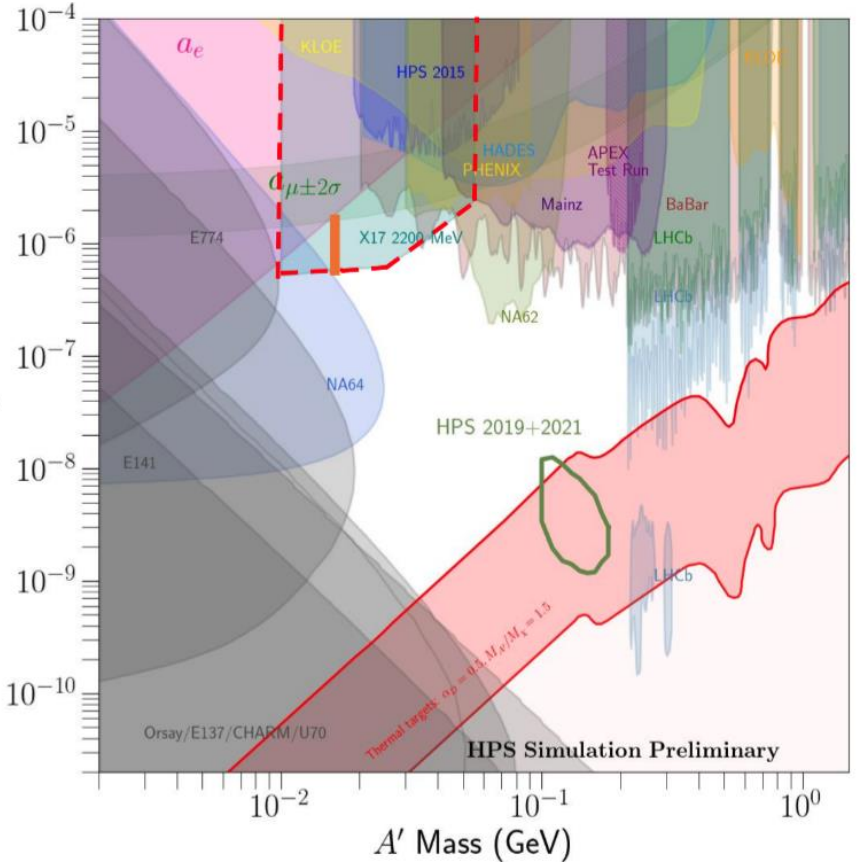
Simultaneous detection of Moller scattering provides important calibration for *ep*-elastic cross-section.

Upcoming run, X17

Electron beam energy 2.2 GeV

$$e + Ta \rightarrow Ta\, e^- e^+ e^-$$





Hall-B runs for 2026-27

Two polarized target experiments are planned (they have to be scheduled together):

- RG-C can run with the existing target material,
- RG-G needs a new target material, a complex process: powder material → pallets → irradiation. The facility is still under construction in the injector.

If these experiments are not ready to pass ERR, the decision will be made to move to the backup plan within a year.

The backup options are two: one is straightforward, requiring no changes to the hall or new equipment.

SAD or scheduled Run Group	Setup / Status	Target	Beam Energy	Start Date	End Date	Scheduled Calendar Days	Remaining PAC Days Before Run	Scheduled PAC Days = Cal.Days/2	Actual PAC Days from ABUs	Remaining PAC Days After Run
RG-C		long. polarized NH3/ND3	11			80	40	40		0
E12-14-001		long. polarized 7LiD	11			110	55	55		0
SAD 2027							**sum:**	**95**		

SAD or scheduled Run Group	Setup / Status	Target	Beam Energy	Start Date	End Date	Scheduled Calendar Days	Remaining PAC Days Before Run	Scheduled PAC Days = Cal.Days/2	Actual PAC Days from ABUs	Remaining PAC Days After Run
RG-E		liq. D2 & nucl. doublet	11			66	33	33		0
	reconfigure	change				7		4		
HPS	HPS setup	nuclear	4,4			120	105	60		45
							sum:	**97**		

SAD or scheduled Run Group	Setup / Status	Target	Beam Energy	Start Date	End Date	Scheduled Calendar Days	Remaining PAC Days Before Run	Scheduled PAC Days = Cal.Days/2	Actual PAC Days from ABUs	Remaining PAC Days After Run
RG-E		liq. D2 & nucl. doublet	11			66	33	33		0
	reconfigure	change				7		4		
RG-K		liq. H2	8,4			120	52	60		0
							sum:	**97**		

New CLAS12 proposals: DDVCS

Closing the loop on virtual Compton scattering

JLAB Flagship program – accessing GPDs through measurements of beam/target asymmetries and the cross sections of Compton processes (TCS and DVCS)

Jefferson Lab at the luminosity frontier is the only place in the world DDVCS can be measured!

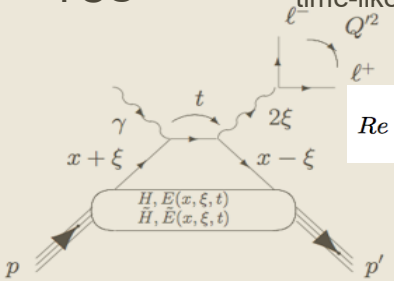
μCLAS12 in Hall B and SoLID in Hall A are the two proposed facilities capable of carrying out such measurements.

First experimental measurement with CLAS12 PRL 127, 262501 (2021)

Started in 2001, PRL 87, 182002. Now is the flagship physics program

TCS

Hard scale is defined by time-like photons



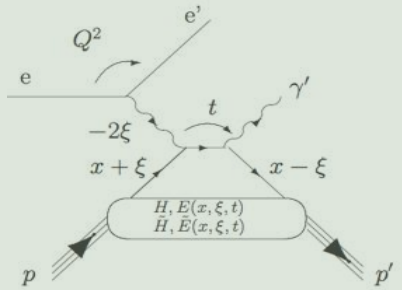
$$Re\ \mathcal{H}(\xi,t) = PV \int_{-1}^{1} dx\, C^{-}(\xi,x) H(x,\xi,t)$$

$$Im\ \mathcal{H}(\xi,t) = i\pi H(\xi,\xi,t)$$

Access to the Re-part of the Compton amplitude

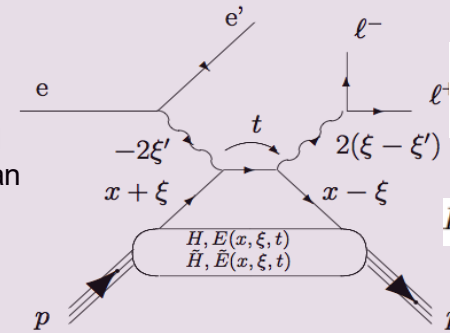
DVCS

Hard scale is defined by space-like photon



DDVCS

Both space-like and time-like photons can set the hard scale



$$\int_{-1}^{+1} dx \frac{H(x,\xi,t)}{x-(2\xi'-\xi)+i\epsilon} + \ldots$$

$$H(2\xi'-\xi,\xi,t) + H(-(2\xi'-\xi),\xi,t)$$

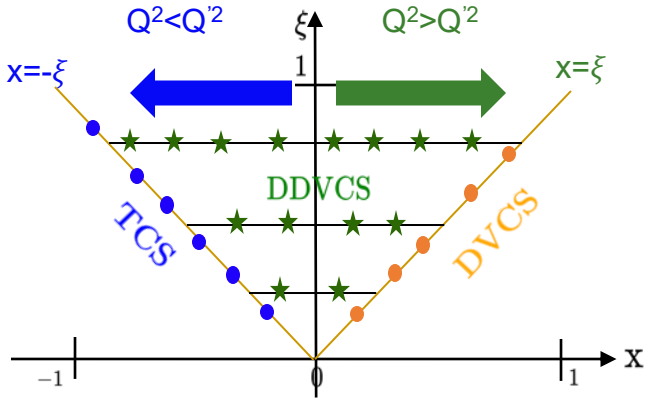
σ-DDVCS is three orders of magnitude smaller than σ-DVCS

CFFs and GPDs in Virtual Compton Scattering

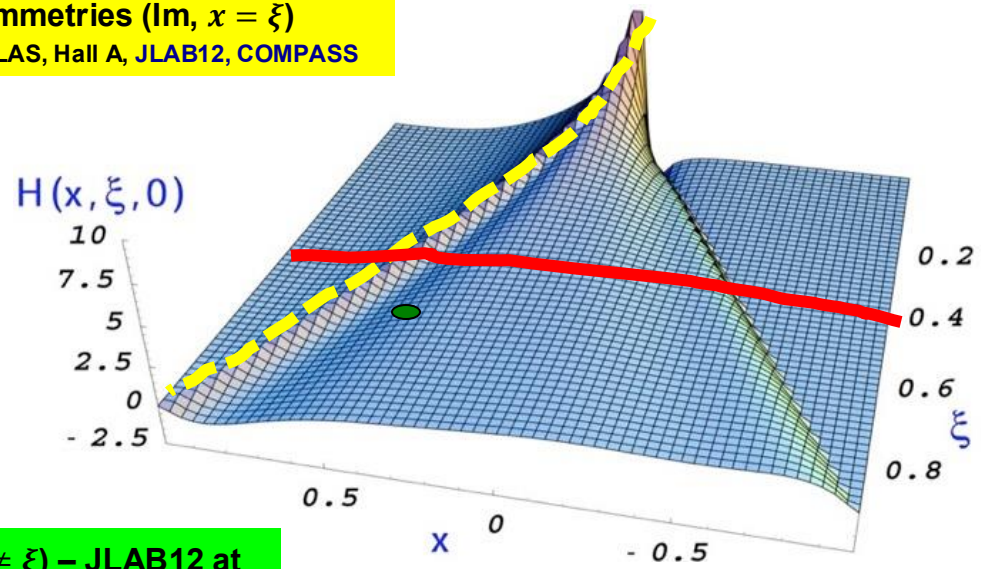
$$\mathcal{T}_{DVCS} \sim CFF\ \mathcal{H}(\xi,t) \propto i\pi[H(\xi,\xi,t) - H(\xi,\xi,t)] + P\int_{-1}^{+1} dx\left(\frac{1}{x-\xi} \pm \frac{1}{x+\xi}\right)[H(x,\xi,t) \mp H(x,\xi,t)]$$

(the same for TCS)

$$\mathcal{T}_{DDVCS} \sim CFF\ \mathcal{H}(\xi,\xi',t) \propto i\pi[H(2\xi'-\xi,\xi,t) - H(-2\xi'+\xi,\xi,t)] + P\int_{-1}^{+1} dx\left(\frac{1}{x-(2\xi'-\xi)} \pm \frac{1}{x+(2\xi'-\xi)}\right)[H(x,\xi,t) \mp H(x,\xi,t)]$$



Spin asymmetries (Im, $x = \xi$)
HERMES, CLAS, Hall A, JLAB12, COMPASS



DDVCS (Im, $x \neq \xi$) – JLAB12 at $L \geq 10^{37}$ cm^{-2} sec^{-1}

Angular asymmetry in TCS (|Re|)
JLAB12

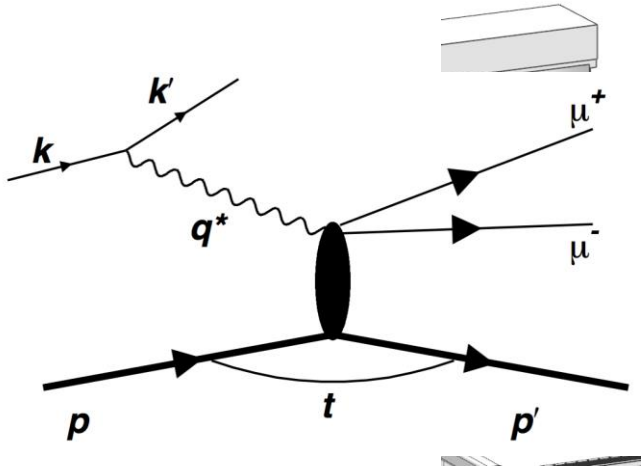
Charge asymmetry in DVCS (|Re|)
HERMES, COMPASS, JLAB12

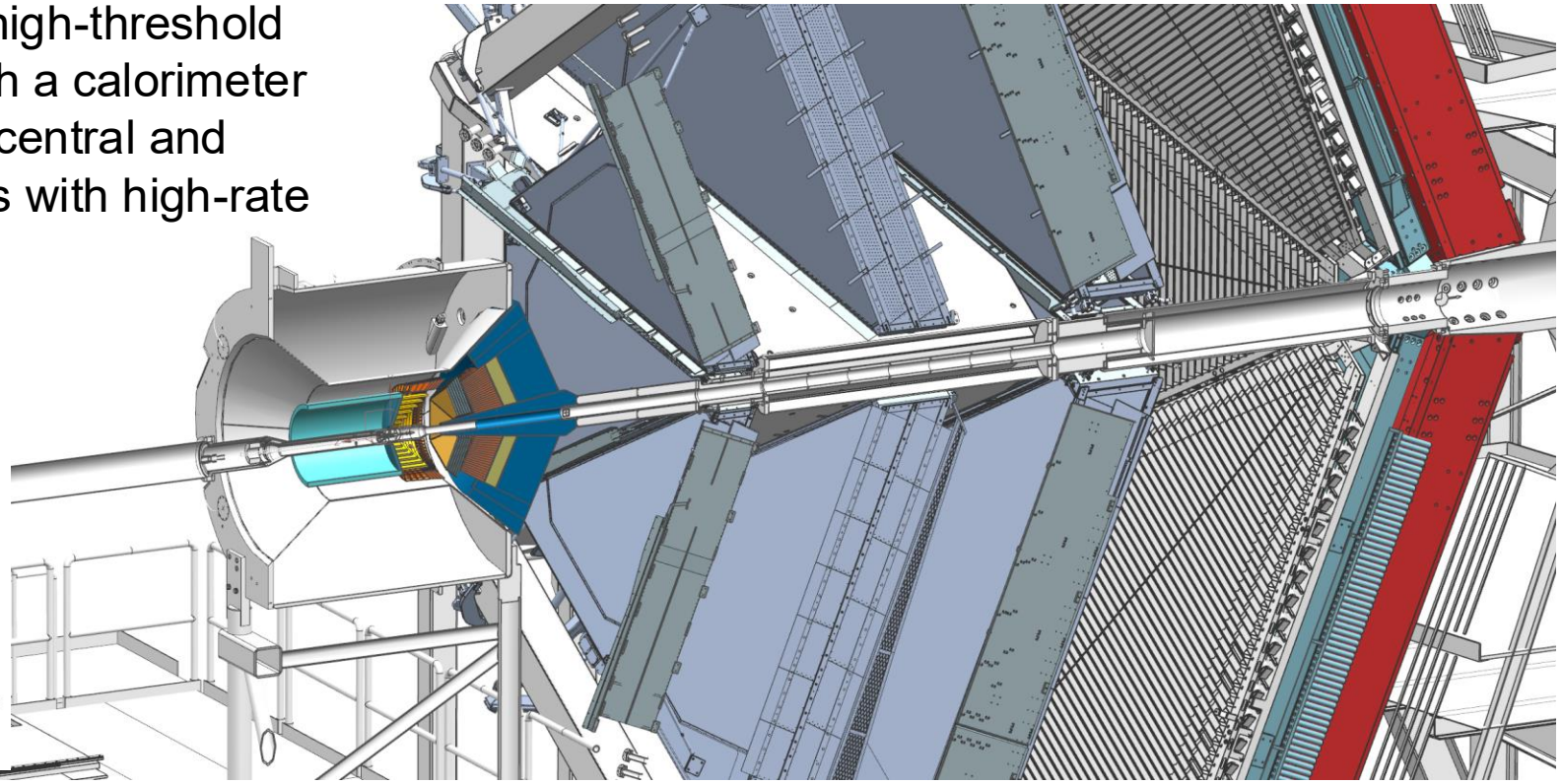
DVCS Cross sections (|Re|^2)
H1, Hall A, JLAB12, COMPASS

Re part of CFFs provides a direct measurement of the D-term and access to the mechanical properties of the proton

μCLAS12 for DDVCS @ $L \geq 10^{37} cm^{-2} sec^{-1}$

- The experiment requires high luminosity, large acceptance, and excellent muon detection.
- The proposal is to replace the high-threshold Cherenkov counter (HTCC) with a calorimeter and shield and to enhance the central and forward vertex tracking systems with high-rate capabilities.



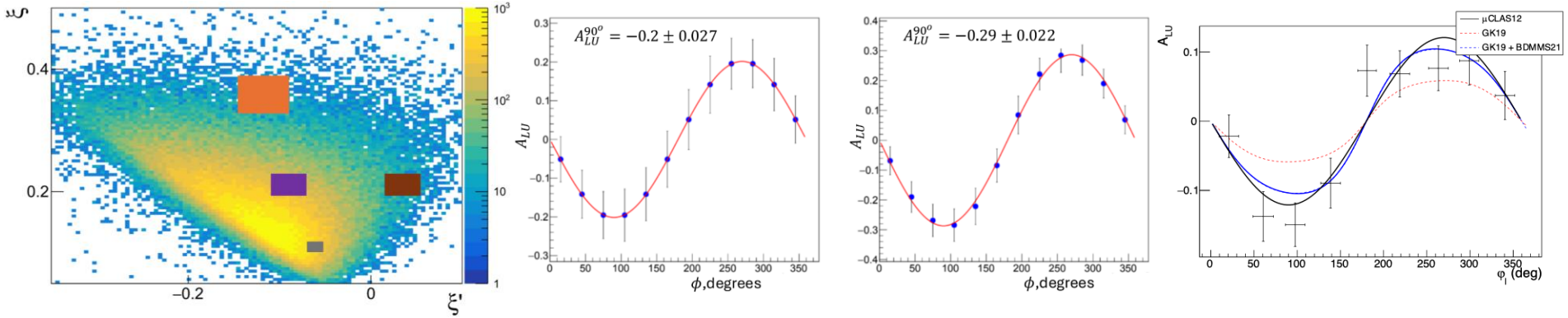


- The proposed running conditions, with a single-arm muon trigger, will allow for high-statistics measurements of J/ψ electroproduction and time-like Compton scattering.

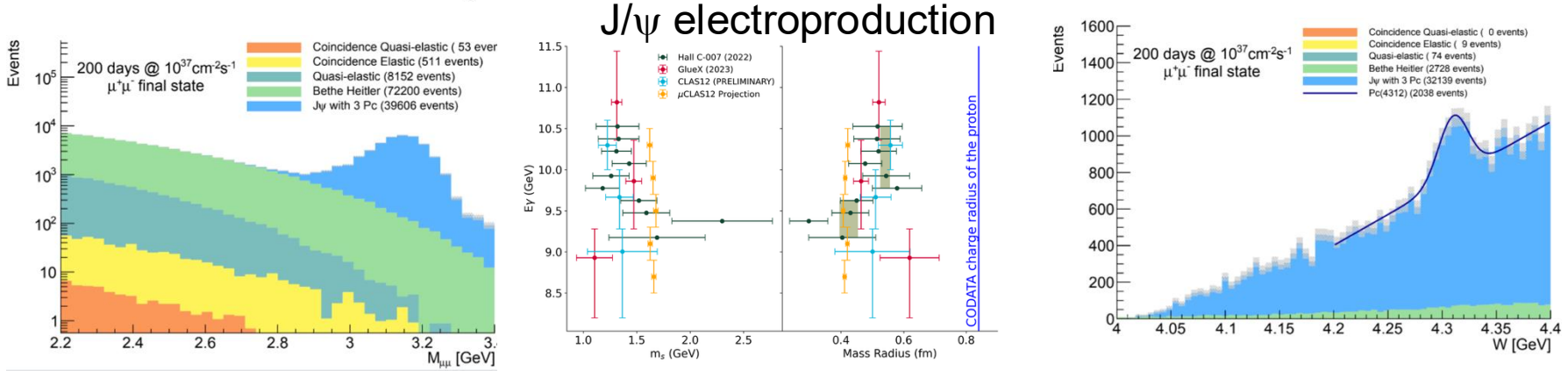
Projections

- To achieve the physics goals, the proposal requested 200 days of beam time for production running at a luminosity of $10^{37} cm^{-2} sec^{-1}$, utilizing an 11 GeV, 7.5 μA electron beam with >85% longitudinal polarization incident on a 5 cm-long liquid hydrogen target.
- In addition, we request 15 days for commissioning the μCLAS12 detector with beam and 30 days for empty target and low-luminosity calibration runs.

DDVCS BSA

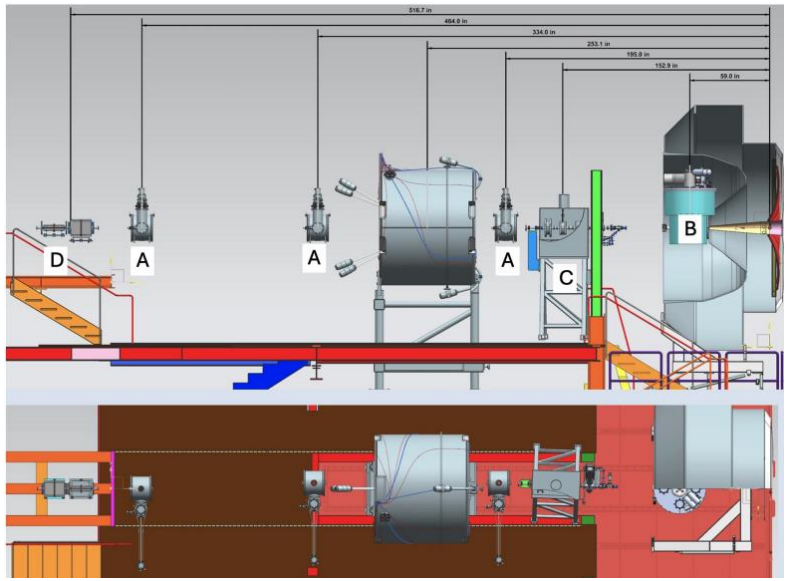


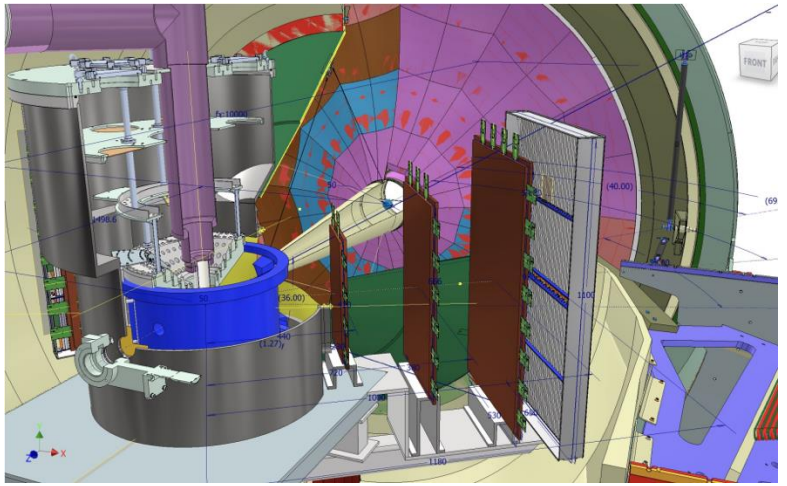
J/ψ electroproduction



Transversely polarized target (RG-H)

- This run group comprises three experiments, which require a transversely polarized target that was originally approved with the HDIce target by PAC39 under C1 condition.
- The three main physics goals of the experiment over 125 days of running at a luminosity of $5 \times 10^{33} cm^{-2} sec^{-1}$ are:
  - Transverse spin effects in SIDIS, $ep^{\uparrow} \rightarrow e'hX$
  - Transversity with dihadron production in SIDIS, $ep^{\uparrow} \rightarrow e'h_1h_2X$
  - Deeply Virtual Compton Scattering, $ep^{\uparrow} \rightarrow e'p'\gamma$
- The run group passed the first jeopardy while transitioning to DNP target (NH3), but in the second jeopardy, PAC52 put the proposal to C2 condition due to major changes in run conditions.
- The significant difference from the original proposal is the use of a 5T transverse field at the target location. This requires a magnetic chicane to keep the beam on the correct path to the dump (similar to HPS).
- Target field creates a high background in the horizontal plane, knocking





Summary

- Continue successfully executing experiments, calibrating and processing data, and physics analysis. Seven CLAS/CLAS12 papers were submitted, and three have already been published in 2025.
- Currently running the ALERT experiment with 10.6 and 6.4 GeV electron beams, a ^{4}He gas target, and a low-energy recoil detector. The program focuses on studying nuclear and nucleon structure.
- Continue efforts with the forward tracking luminosity upgrade.
  - Significant progress has been made in the tracking software to improve track finding efficiency at high occupancies.
  - Fabrication of the second μRWELL prototype is underway. The prototype features the nearly final layout of the envisioned detector for the forward tracker; the details are awaiting software validation.
- The next experiment in Hall B, PRad/X17, has passed ERR and is moving at full speed to prepare for the run in January 2026. This is a significant installation for a short SAM period.
- The experimental schedule in Hall B beyond summer 2026 is not firm and depends on the readiness of tentatively planned experiments.
- After the 2026 run period, with already approved beam time, we have about six years to run, assuming 30 weeks per year for physics. This year's run will be 20 weeks.
- Two new proposals have been submitted to PAC53, requesting about 300 PAC days of beam time (three calendar years) to Hall B's raster.

Hall B – Run Groups

Table 1: Run groups A and B (CLAS12), 20 experiments

Proposal	Physics	Contact	Rating	Days	Group	New equipment	Energy	Run Group	Target	Complete
E12-06-108	Hard exclusive electro-production of π^0, η	Stoler	B	80	139	RICH (1 sector) Forward tagger	11	**A** F. Sabatié	liquid H_2	50%
E12-06-108A	Exclusive N*->KY Studies with CLAS12	Carman		(60)						
E12-06-108B	Transition Form Factor of the η' Meson with CLAS12	Kunkel		(80)						
E12-06-112	Proton's quark dynamics in SIDIS pion production	Avakian	A	60						
E12-06-112A	Semi-inclusive Λ productiuon in target fragmentation region	Mirazita		(60)						
E12-06-112B	Colinear nucleon structure at twist-3	Pisano		(60)						
E12-06-119(a)	Deeply Virtual Compton Scattering	Sabatie	A	80						
E12-09-003	Excitation of nucleon resonances at high Q^2	Gothe	B+	40						
E12-11-005	Hadron spectroscopy with forward tagger	Battaglieri	A-	119						
E12-11-005A	Photoproduction of the very strangest baryon	Guo		(120)						
E12-12-001	Timelike Compton Scatt. & J/ψ production in e+e-	Nadel-Turonski	A-	120						
E12-12-001A	Near Threshold J/ψ photoproduction and study of LHCb pentquarks	Stepanyan		(120)						
E12-12-007	Exclusive φ meson electroproduction with CLAS12	Stoler, Weiss	B+	60						
E12-07-104	Neutron magnetic form factor	Gilfoyle	A-	30	90	Neutron detector RICH (1 sector) Forward tagger	11	**B** K. Hafidi	liquid D_2 target	43%
E12-09-007(a)	Study of partonic distributions in SIDIS kaon production	Hafidi	A-	30						
E12-09-008	Boer-Mulders asymmetry in K SIDIS w/ H and D targets	Contalbrigo	A-	56						
E12-09-008A	Hadron production in target fragmentation region	Mirazita		(60)						
E12-09-008B	Colinear nucleon structuer at twist-3	Pisano		(60)						
E12-11-003	DVCS on neutron target	Niccolai	A	90						
E12-11-003A	In medium structure functions, SRC, and the EMC effect	Hen		(90)						
Total beam time for PAC approved (all) experiments / Run Groups				**765 (1355)**	**229**					

Hall B – Run Groups

Table 2: Run groups C, D, E, F, G and H (CLAS12), 13 experiments

Proposal	Physics	Contact	Rating	Days	Group	Equipment	Energy (GeV)	Group	Target	Complete
E12-06-109	Longitudinal Spin Structure of the Nucleon	Kuhn	A	80	~~185~~ 120	Longitudinaly Polarized target RICH (1 sector) Forward tagger	11	C S. Kuhn	NH_3 ND_3	
E12-06-109A	DVCS on the neutron with polarized deuterium target	Niccolai		(60)						
E12-06- 119(b)	DVCS on longitudinally polarized proton target	Sabatie	A	120						
E12-07-107	Spin-Orbit Correl. with Longitudinally polarized target	Avakian	A-	103						
E12-09-007(b)	Study of partonic distributions using SIDIS K production	Hafidi	A-	80						
E12-09-009	Spin-Orbit correlations in K production w/ pol. targets	Avakian	B+	103						
E12-06-106	Color transparency in exclusive vector meson production	Hafidi(El Fassi)	B+	~~60~~ 30	30		11	D		
E12-06-106A	Nuclear TMDs in CLAS12	Dupre		(30)						
E12-06-117	Quark propagation and hadron formation	Brooks	A-	60	60		11	E	Nuclear	
E12-06-113	Free Neutron structure at large x	Bueltman	A	42	42	Radial TPC	11	F	Gas D_2	100%
E12-14-001	EMC effect in spin structure functions	Brooks	B+	55	55	Pol. target, Li	11	G	6LiH/7LiD	
C12-11-111	SIDIS on transverse polarized target	Contalbrigo	A	110	110	Transversely polarized target	11	H	HD	
C12-12-009	Transversity w/ di-hadron on transvere target	Avakian	A	110						
C12-12-010	DVCS with transverse polarized target in CLAS12	Elouadrhriri	A	110						
Total beam time for PAC approved (all) experiments / Run Groups (+ C1)				**1003 (1093)**	**307 (417)**					

Table 3: Run groups I and J (non-CLAS12), 2 experiments

Proposal	Physics	Contact	Rating	Days	Group	Equipment	Energy (GeV)	Group	Target	Complete
E12-11-006	Heavy Photon Search at Jefferson Lab (HPS)	Jaros	A	180	180	Setup in alcove	2.2, 6.6	I	Nuclear	56.7%
E12-11-106	High Precision Measurement of the Proton Charge Radius	Gasparian	A	15	15	Primex	1.1, 2.2	J	H2 gas	100%
Total beam time for PAC approved non-CLAS12 experiments				**195**	**305**					

Hall B – **Run Groups**

Table 4: Run groups K, L, M, N, and P (CLAS12), and O (PRad), 12 experiments

Proposal	Physics	Contact	Rating	Days app.	Group	Equipment	Energy (GeV)	Group	Target	Completed
E12-16-010	A search for Hybrid Baryons in Hall B with CLAS12	D'Angelo	A-	100	**100**	Forward Tagger	6.6, 8.8	**K** Confinement & Strong QCD	**LH2**	**12%**
E12-16-010A	Nucleon Resonances in exc. KY electroproduction	Carman	A-	(100)						
E12-16-010B	DVCS with CLAS12 at 6.6 and 8.8 GeV	Elouadrhiri	A-	(100)						
E12-17-012	Partonic Structure of Light Nuclei	Meziani	A-	55	**55**	ALERT detector	11	**L**	**High pressure gas H, D, 4He**	
E12-17-012A	Tagged EMC measurements on Light Nuclei	Dupre								
E12-17-012B	Spectator-Tagged DVCS on Light Nuclei	Armstrong								
E12-17-012C	Other Physics Opportunities with ALERT	Hafidi								
E12-17-006	Electrons for Neutrinos: Addressing Critical Neutrino-Nucleus Issues	O. Hen	A	45	**45**	No-FT	1.1, 2.2, 4.4, 6.6	M	**Nuclear**	
E12-18-003	Exclusive Studies of Short Range Correlations in Nuclei using CLAS12	O. Hen		(45)						
C12-20-002	A program of spin-dependent electron scattering using a polarized 3He target in CLAS12	Milner	A-	30	**30**	Tr. 3He gas target	11	N	**T_Pol-3He**	
C12-20-004	PRad-II: A New Upgraded High Precision Measurement of the Proton Charge Radius	Gasparian	A	40	**40**	PRAD upgrade	0.7, 1.4, 2.1	O	**Gas-jet H/D**	
E12-20-005	Precision measurements of A=3 nuclei in Hall B	Szumila-Vance	A-	60	**60**	Tritium target	2.2, 6.6	P	**3H/3He**	
Total beam time for PAC approved (all) experiments / Run Groups (+ C1)				**290 (535)**	**260 (290)**					

Beam time for approved & C1 approved (all) CLAS12 experiments from Table 1, 2, 3, and 4 / Run Groups (+ C1)	**2058(2983)**	**796 (936)**
Beam time for all Hall B experiments, approved & C1 approved (all) CLAS12 experiments / Run Groups (+ C1)	**2293 (3218)**	**991 (1171)**

Total completed 255 PAC days

Table 5: C2 approved experiment, CLAS12 and PRad

PR12-20-009	Beam charge asymmetries for Deeply Virtual Compton Scattering on the proton at CLAS12	Voutier	C2	100	**100**	Positron beam	11 e+/-		**LH2**
PR12-21-003	A Direct Detection Search for Hidden Sector New Particles in the 3-60 MeV Mass Range	Gasparian	C2	60	**60**		2.2, 3.3		**Ta**
PR12-21-004	Semi-Inclusive Deep Inelastic Scattering Measurement of A=3 Nuclei with CLAS12 in Hall B	Weinstein	C2	58	**58**		11		**D/3H/3He**

Summary of Hall-B Run Groups and PAC days

In the tables, Experiment ending with A or B are run group experiments approved by the CLAS collaboration. They are running parallel to the experiments with same experiment number. Experiments ending with (a) and (b) take data with both run groups.

Proposal Count	Experiment Days	Run Groups	RG PAC days	Compression	Completed PAC days
47	3188	14	1171	0.37	255

With expected experiment schedule of 30 weeks per year:

- 30 weeks per year ≈ 30/2 = 15 PAC weeks = 105 PAC days
- To run remaining 2933 PAC days of individual experiments = 30 years
- To run remaining 916 PAC days as run groups = ~9 years

Run Group	Approved PAC days	Used beam time	Calibration	Pass1	Pass2	Comments
RG-A	139	~50%	30%	30%	validation	1st portion (Spring 2018) is an issue
RG-B	90	~43%	100%	100%	validation	Can be the first to be ready for pass2
RG-K	100	~12%	100%	100%		
RG-F	42	100%	ongoing			Still working on RTPC calibration
RG-M	45	80%	ongoing			The goal is to be ready for data processing in 6 months

Hall-B run groups ready to run in 2026 and beyond

- **RG-A** and **RG-B** still have a significant portion of their approved beam time remaining, 70 and 40 PAC days, respectively.

  These two run groups are the main beneficiaries of the forward tracking upgrade.
- **RG-E** remaining 30 PAC days.
- **RG-K** remaining beamtime, about 50 PAC days, at 6.6 and 8.8 GeV.
- **RG-M** has 10 days at 1.1 GeV, non-standard energy.
- Non-CLAS12 experiment
  - **RG-I**, Heavy photon search (HPS), still has 102 PAC days to run. Low energy experiment, 2-4 GeV.

With 30 weeks a year for physics, this will take 2.5+ years.

Other Hall-B run groups

- Other CLAS12 experiments have non-trivial targets (in the order of group definitions):
  - RG-G, longitudinally polarized ^{6}LiH and ^{7}LiD targets. Will be RG-C target system, somewhat modified. But, will need 3 years to get the samples ready.
  - RG-H, transversely polarized target, target choice DNP NH_3. Major engineering work, there are long lead-time, expensive items to purchase and install (chicane magnets and PSs). Will need >3 years to get ready.
  - RG-N, longitudinally polarized ^{3}He gas target. C1 approved for 30 PAC days. Target is in the development stage, no exact timeline.
  - RG-P, ^{3}H/^{3}He targets with 2.2 and 6.6 GeV beams. Another experiment with the same target-set, but at 11 GeV, C2 approve, is going back to PAC50. Long preparation and installation time, hall will be down for about a year. Conditions in the hall will/may affect detectors.

Proponents of these experiments have to start the planning process, make their requests to the hall and get ready for ERR. Multiple groups will be involved in these installations, some are lengthy and expensive.