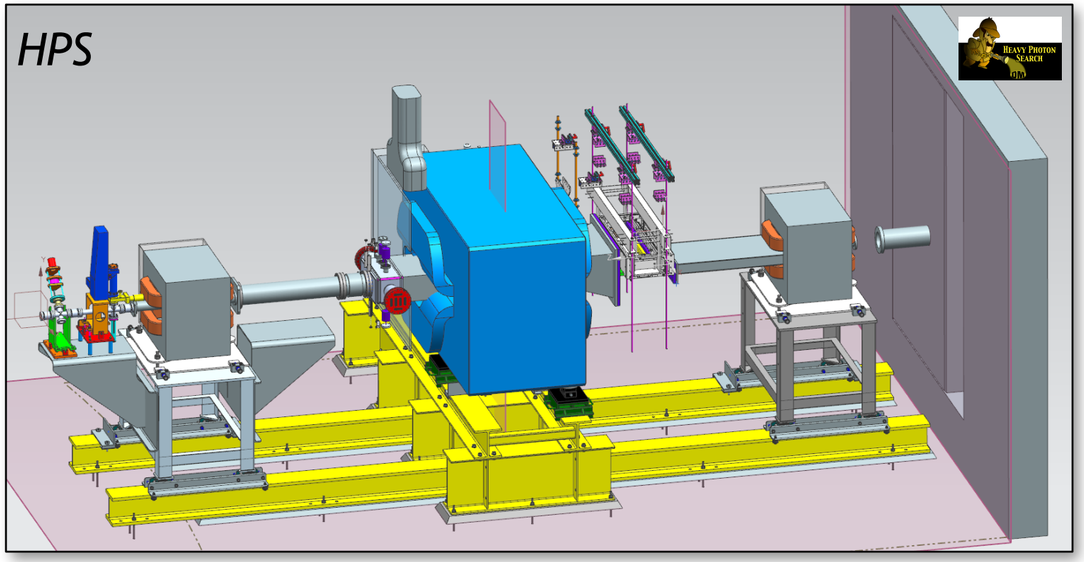
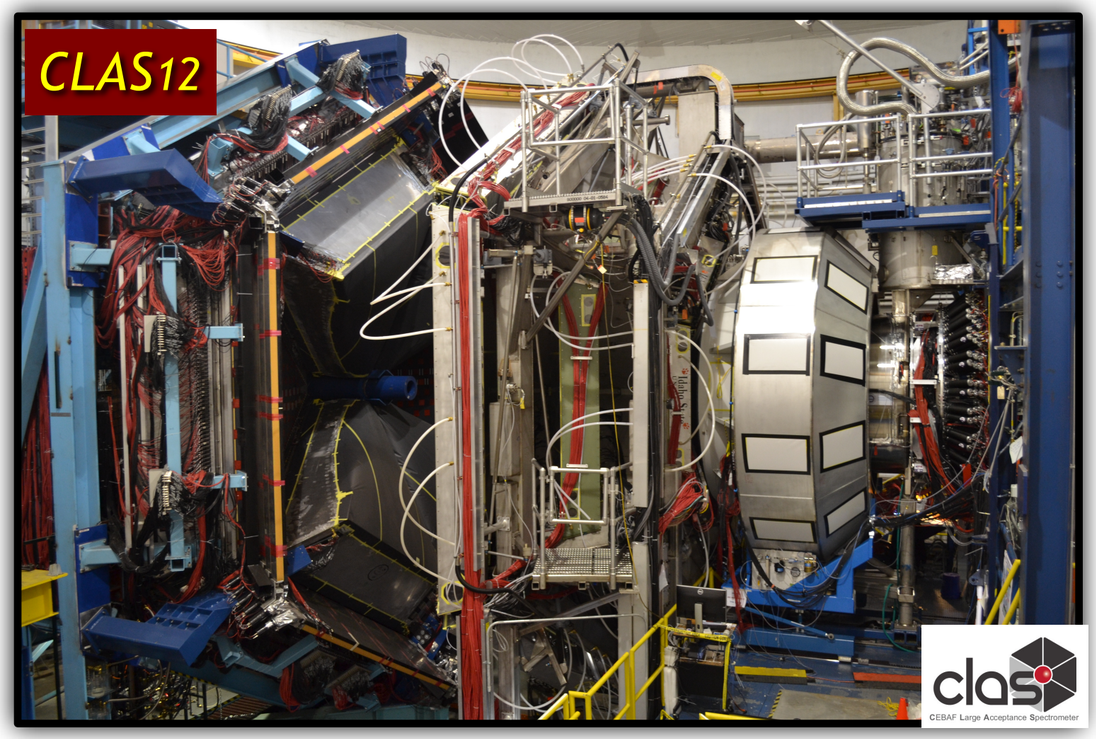
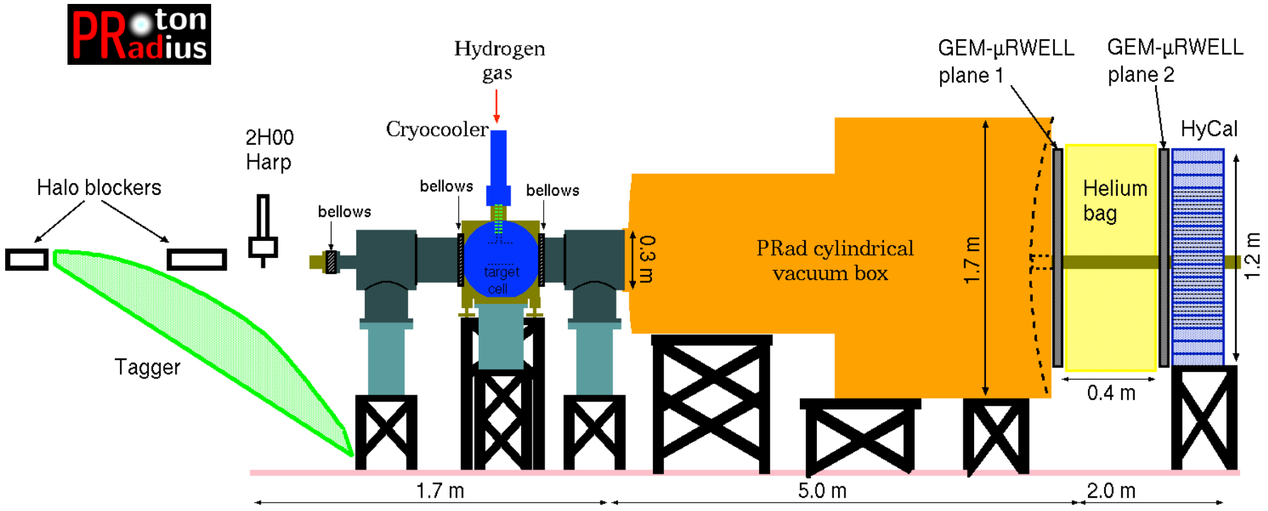






HPS Collaboration Meeting
Nov 15-17, 2021

Status of Hall B

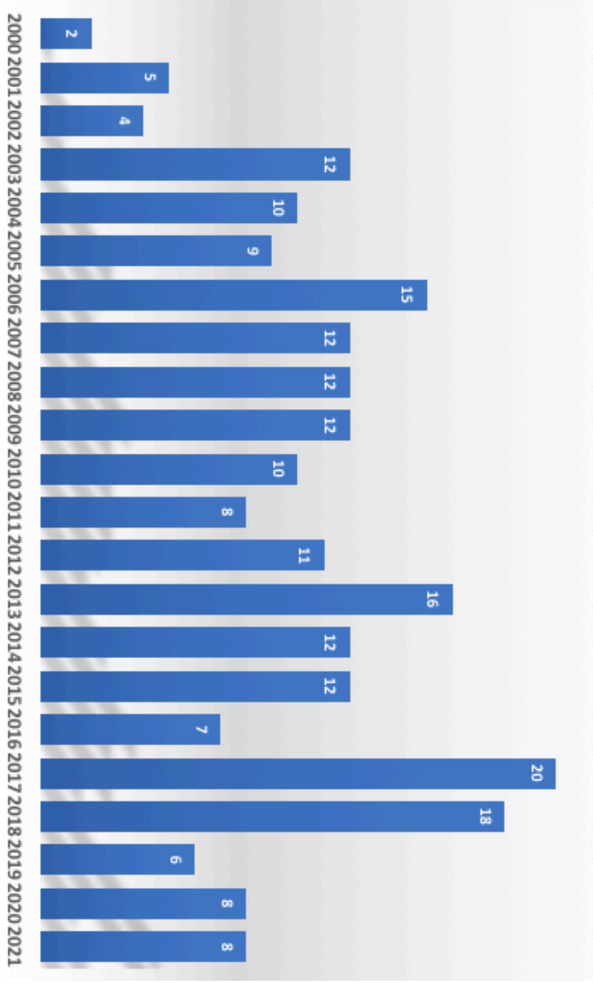
Marco Battaglieri
Jefferson Lab

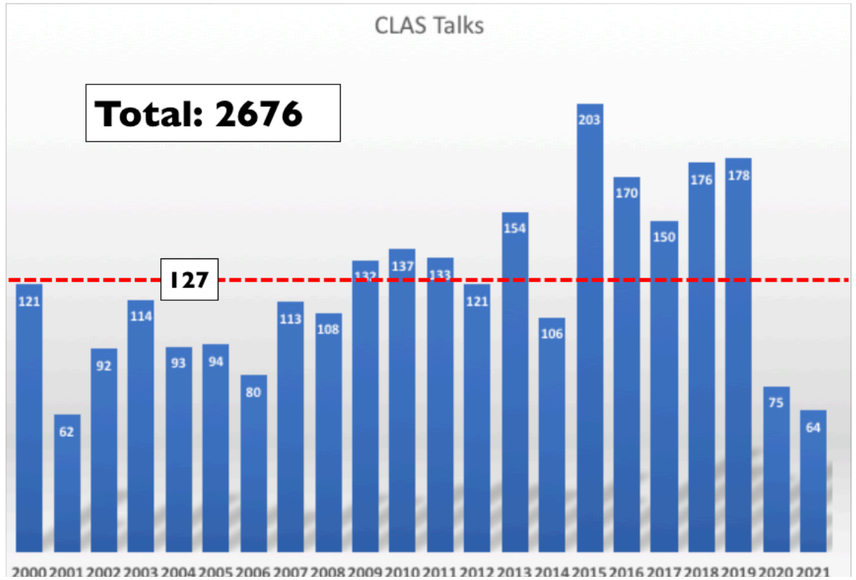
Refereed Physics Publications

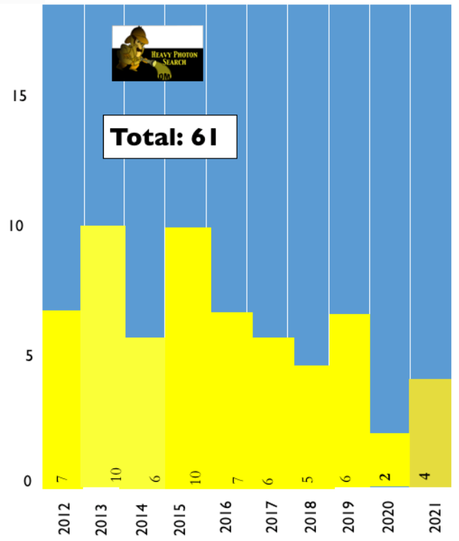
Hall B

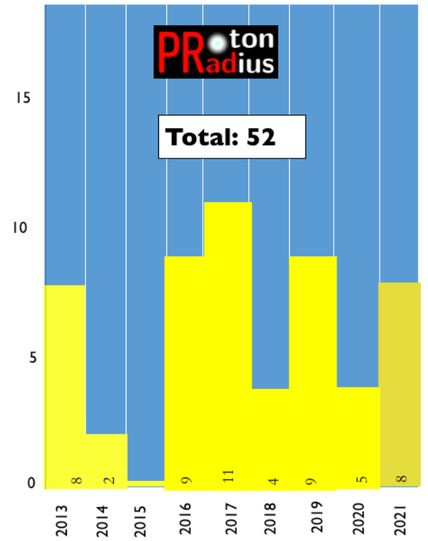
	Spectroscopy	Hard Scattering	Nuclear	ALL
2000		1	1	2
2001	2	3		5
2002	3		1	4
2003	7	4	1	12
2004	3	3	4	10
2005	7	3	2	9
2006	8	4	3	15
2007	7	2	3	12
2008	4	6	2	12
2009	8	7	4	12
2010	4	2	4	10
2011	3	1	4	8
2012	6	3	2	11
2013	8	6	2	16
2014	5	6	1	12
2015	4	5	3	12
2016	7			7
2017	12	7	1	20
2018	10	6	2	18
2019	1	2	3	6
2020	5	1	2	8
2021	2	4	2	8
SUM	116	66	47	229

- + 1 CLAS paper accepted by Nature Physics
- + 3 CLAS paper submitted
- + 2 CLAS12 papers submitted





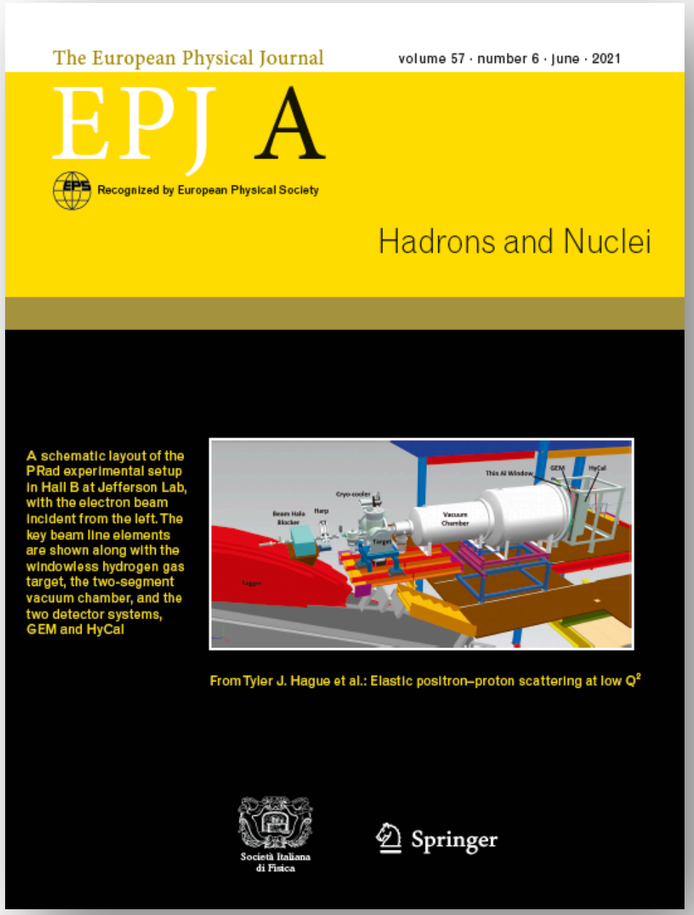




updated 11/08/2021

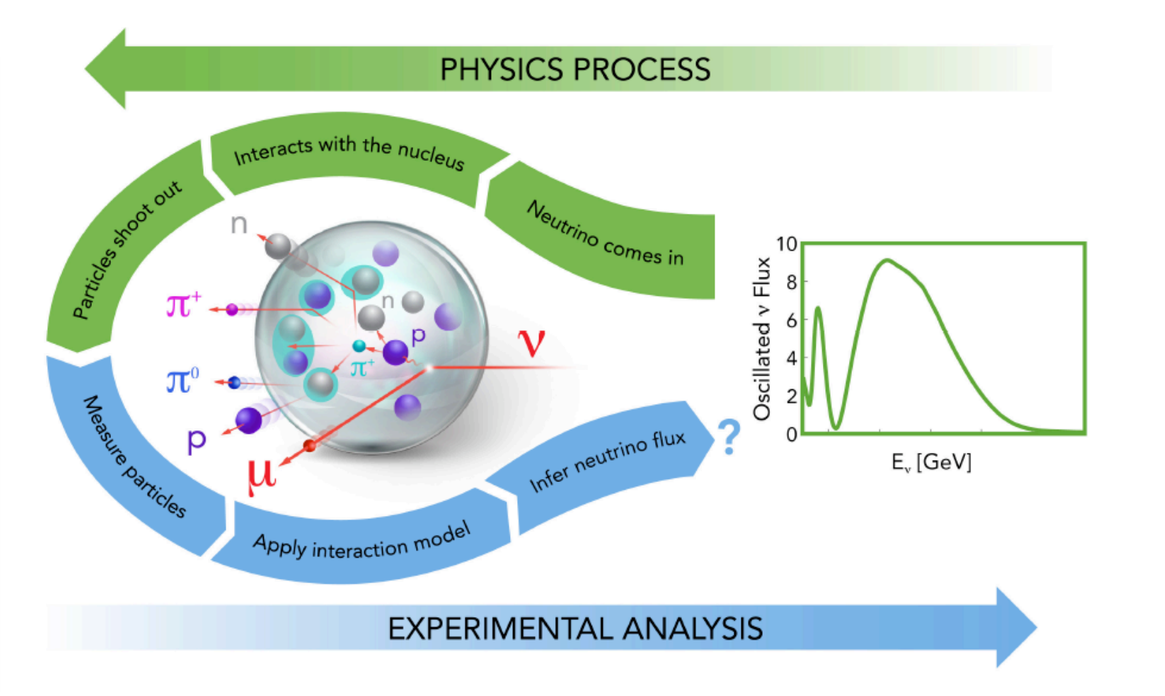
Highlights

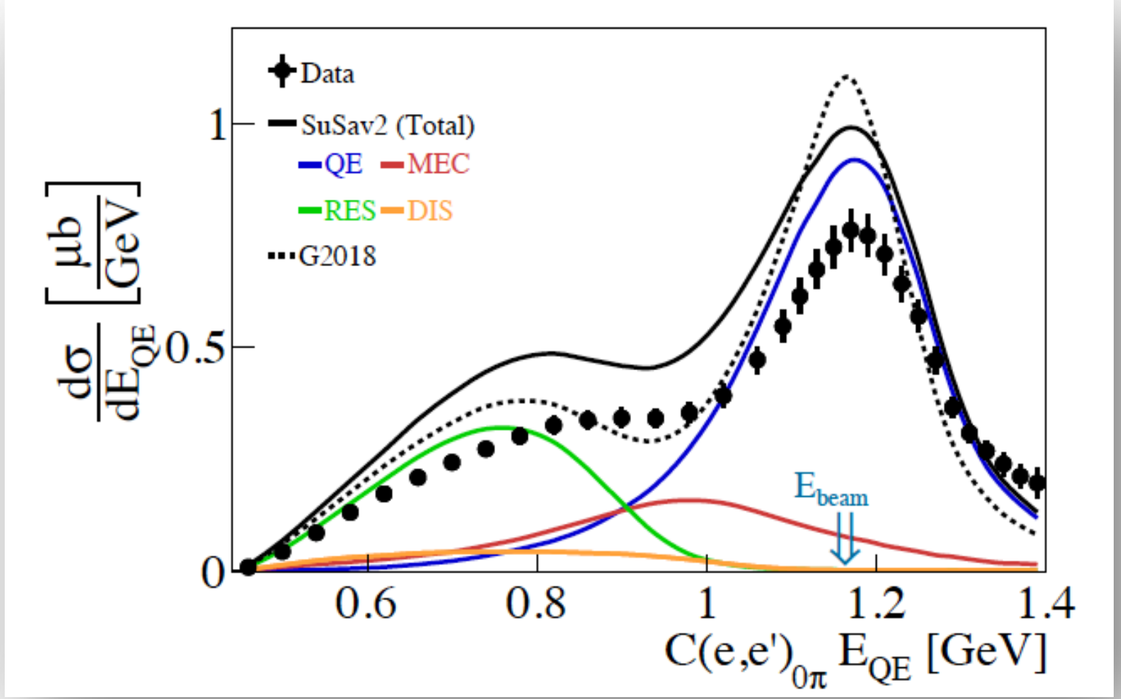
- **CLAS12 physics runs:**
  - RG-A (13 proposals,139 PAC days) - partial -
  - RG-K (3 proposals, 100 PAC days) - partial -
  - RG-B (7 proposals, 90 PAC days) - partial -
  - RG-F (BONUS, 42 PAC days) - concluded -
- **Continued flow of results from Hall B (CLAS+PRAD+HPS+PRIMEX..)**
  - ~ 230 physics papers in peer reviewed journals (> 14,000 citations)
  - 5 papers in **Nature** (+1 Nature Phys.), 1 paper in **Science**
  - >2,670 conference talks (~1,690 invited)
- **Specialized Hall B experiments**
  - PRAD experiment – results published in **Nature**
  - PRIMEX - results published in **Science**
  - Heavy Photon Search - Fall 21 run just ended
- **New Hall-B staff members: welcome on board!**
  - Joseph Newton (post-doc)
  - Florian Hauenstein (Staff Scientist)



Electron Beam Energy Reconstruction for Neutrino Oscillation Measurements

To appear in ***Nature*** *11/25/2021 issue*





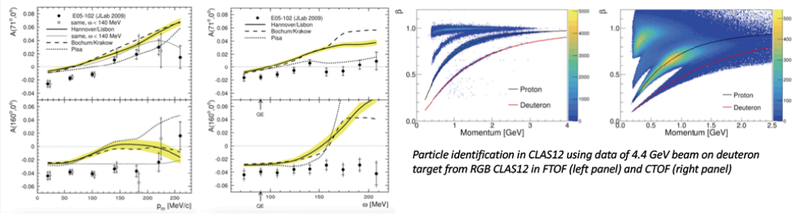
- **CLAS6 data mining activity**
- **Use measured electron-nucleus interaction to test the (vector current) ν-nucleus interaction**
- **Neutrino oscillate as a function of (L/E): exps measure E at different L**
- **E is not directly measured: reconstructed via final state particles**
- **Use e-A interaction with know E_{beam} to test the capability of reconstructing E from the final state**

Proposal ID	Hall	Title	Contact Person		Days	Topic
Letters of Intent						
LOI12-21-001	C	3N Short-Range Correlations	Nadia Fomin	fomin@jlab.org	n/a	5
LOI12-21-002	A	Measurement of the Tensor Observable Azz using SoLID	Elena Long	elena.long@unh.edu	19	5
LOI12-21-003	B	Exploring fundamental properties of 3He through the 3He(e,e'd) process in CLAS12	Douglas Higinbotham	doug@jlab.org	n/a	5
LOI12-21-004	A	Measurement of the Deuteron Tensor Structure Function b1 with SoLID	Karl Slifer	karl.slifer@unh.edu	17	3
Conditional						
C12-19-002	A	High accuracy measurement of nuclear masses of Lambda hyperhydrogens	Toshiyuki Gogami	gogami@jlab.org	14.5	5
New Proposals						
PR12-21-001	C	Measurement of the neutron charge radius through the study of the nucleon excitation	Nikos Sparveris	sparveri@temple.edu	9.5	2
PR12-21-002	A	First Measurement of the Flavor Dependence of Nuclear PDF Modification Using Parity-Violating Deep Inelastic Scattering	John Arrington	johna@jlab.org	81	5
PR12-21-003	B	A Direct Detection Search for Hidden Sector New Particles in the 3-60 MeV Mass Range	Ashot Gasparian	gasparan@jlab.org	60	
PR12-21-004	B	Semi-Inclusive Deep Inelastic Scattering Measurement of A=3 Nuclei with CLAS12 in Hall B	Larry Weinstein			
PR12-21-005	A	Double Spin Asymmetry in Wide-Angle Charged Pion Photoproduction	Bogdan Wojtseki			
PR12-21-006	A	Measurement of the Asymmetry A^{e+e-}_d between e^+ and e^- on $^2H Deep Inelastic Scattering Using SoLID and PEPPo at JLab	Xiaochao Zheng			

Exploring fundamental properties of ^{3}He through the polarized ^{3}He(e,e'd) process in CLAS12

Letter of Intent

Spokespersons: Or Hen, Douglas Higinbotham, Dien Nguyen, and Simon Širca



Particle identification in CLAS12 using data of 4.4 GeV beam on deuteron target from RGB CLAS12 in FTOF (left panel) and CTOF (right panel)

State-of-the-art three-body calculations unable to explain new Hall A data (see references below).

- Hall A results indicate a deficiency in our understanding of the three-body system
  - M. Mihovilovič, et al., Phys. Lett. B 788 (2019) 117. http://doi.org/doi:10.1016/j.physletb.2018.10.063
  - M. Mihovilovic, et al., Phys. Rev. Lett. 113 (2014) 23. http://doi:10.1103/PhysRevLett.113.232505
- The problem is with the limited kinematic range of the data, it is not possible to disentangle what is wrong
- By taking data in CLAS12 will enable a huge range in Q^2, P_{m}, omega to be covered.
- Experiment would like two orthogonal pol. ^{3}He directions with ~30 gauss holding field which requires R&D
- Results are important for all high precision experiments which wish to use polarized ^{3}He as an effective neutron target.

SIDIS Experiments with A=3 Nuclei using CLAS12

Spokespeople: D. Dutta, D. Gaskell, O. Hen, D. Meekins, D. Nguyen, L. Weinstein, J.R. West, Z.H. Ye

- Study Flavor-Dependent EMC Effect in A=3 by measuring SIDIS ratios of 3He and 3H $(e,e'\pi^+)$ and $(e,e'\pi^-)$
  - In $Z \neq N$ different medium effect on u- & d-quark ?
    - ✓ If N>Z, u-quark is more "bound" → ^{3}H
    - ✓ If N<Z, d-quark is more "bound" → ^{3}He

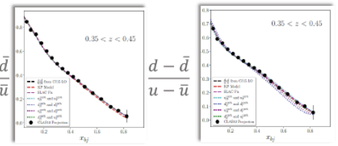
I. Cloet, et al, PRL 109, 182301 (2012); PRL 102, 252301 (2009)]

$$R^{\pi,\pm}_{A_1/A_2}(x,z) = \frac{4(u_{A_1} \pm \bar{u}_{A_1}) \pm (d_{A_1} \pm \bar{d}_{A_1})}{4(u_{A_2} \pm \bar{u}_{A_2}) \pm (d_{A_2} \pm \bar{d}_{A_2})} \cdot \frac{D^{fav}_{A_1} \pm D^{unfav}_{A_1}}{D^{fav}_{A_2} \pm D^{unfav}_{A_2}} = A^{\pi,\pm}_{A_1/A_2}(x) \cdot B^{\pi,\pm}_{A_1/A_2}(z)$$

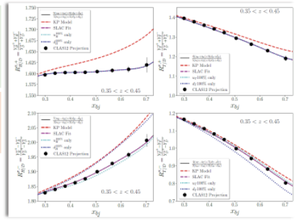
- ✓ Probe the iso-spin dependence of the EMC effect
- ✓ Directly study the EMC effects of u- and d-quarks in A=3
- ✓ Fragmentation Functions (FFs) should be small and largely cancel in ratios

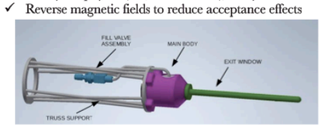
- Directly probe d/u ratios at large-x:

$$\frac{d+\bar{d}}{u+\bar{u}} \qquad \frac{d-\bar{d}}{u-\bar{u}}$$



- Precision Measurements of the A=3 TMDs and FFs in 4D (Q2, x, z, pT) binning
- Study Strangeness Contents in A=3 with kaons (if RICH)
- Experimental Settings:
  - ✓ Standard CLAS12 Configuration
  - ✓ Same target system in Tritium-SRC (E12-20-005)
  - ✓ 50 days of physics (D2, H3 and He3), 8 days calibration runs
  - ✓ Reverse magnetic fields to reduce acceptance effects





Search for Hidden Sector New Particles in the 3 – 60 MeV Mass Range

- New (hidden) particle in MeV-scale mass range in forward electroproduction reactions from a heavy A solid target.

$e^- + Ta \rightarrow e' + \gamma^* + Ta \rightarrow e' + X + Ta^*$,
$X \rightarrow e^+e^-$ (with tracking)
or $X \rightarrow \gamma\gamma$ (without tracking)

Mass range: [3 ÷ 60] MeV

- Target: Tantalum ($_{73}Ta^{181}$) film, thickness: 1 μm, 2.5x10^{-4} r.l.
  density: 16.69 g/cm^3
  N(Ta) = 0.56x10^{+19} atoms/cm^2

Experimental method:

✓ "bump hunting" in the invariant mass spectrum over the beam background.

✓ direct detection of decay particles (e^+e^-) and scattered e^-

Detection criteria:

- scattered electron is in the $PbWO_4$ acceptance with E_e = [30MeV to 0.7xE_{beam}];
- decay e^- and e^+ are in the $PbWO_4$ within energy: [0.03 – 0.8xE_{beam}]
- Target to PbWO4 distance L=7.5 m beam energy optimized for E_e = 2.2 GeV and 3.3 GeV

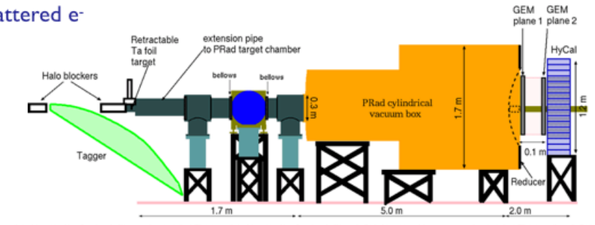
Beam time request

	Time [days]
Setup checkout, tests and calibration	4.0
Production at 2.2 GeV @ 50 nA	20.0
Production at 3.3 GeV @ 100 nA	30.0
Energy change	0.5
No target background sampling at 2.2 & 3.3 GeV	5.5
Total	60.0

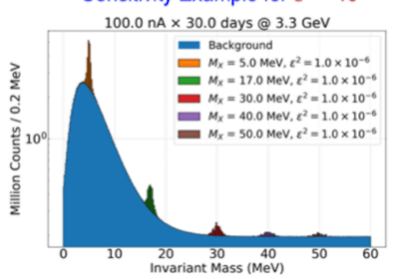
Search sensitivity

m_X MeV	σ_{m_X} MeV	Background Counts	Signal Counts (5.0 Significance)	Lowest ϵ^2	lowest ϵ^2
30 days of 3.3 GeV at 100 nA					combined with signal from 20 days at 2.2 GeV
5.0	0.263	22.02M	23.48k	6.86E-09	5.94E-09
17.0	0.467	3.60M	9.50k	9.83E-09	8.51E-09
30.0	0.692	3.06M	8.76k	2.60E-08	2.25E-08
40.0	0.938	4.08M	10.11k	5.71E-08	4.94E-08
50.0	1.009	4.38M	10.48k	8.37E-08	7.24E-08

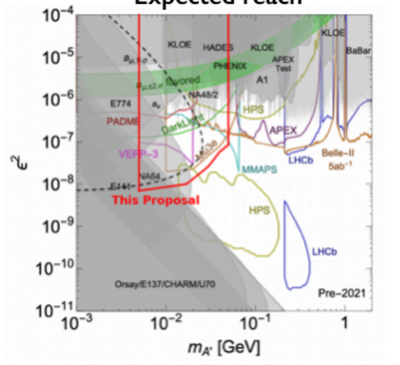
Experimental Setup (Side View)



Sensitivity Example for $\epsilon^2 = 10^{-6}$



Expected reach



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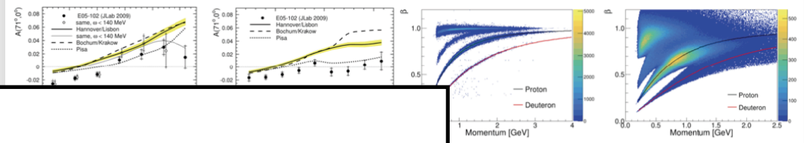
Conditional						
C12-19-002						
New Proposals						
PR12-21-001						
PR12-21-002						
PR12-21-003						
PR12-21-004						
PR12-21-005						
PR12-21-006						

Exploring fundamental properties of ^{3}He
through the polarized ^{3}He(e,e'd) process in CLAS12

Letter of Intent

Spokespersons: Or Hen, Douglas Higinbotham, Dien Nguyen, and Simon Širca



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:10.1103/PhysRevLett.113.232505
possible to disentangle what is wrong
o be covered.
gauss holding field which requires R&D
to use polarized ^{3}He as an effective neutron target.

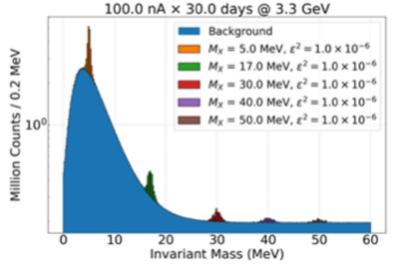
PAC49 report

- **X17 (A. Gasparyan)**: C2, *The scientific motivation of searching for a light dark photon in the MeV mass region is high. The experimental setup is clearly explained in the proposal. It seems feasible and cost effective to run the experiment using a PRad setup to be determined.* ***Given the not fully understood background simulation, the PAC recommends conditional approval*** *of this proposal, with return to a future PAC (C2).*

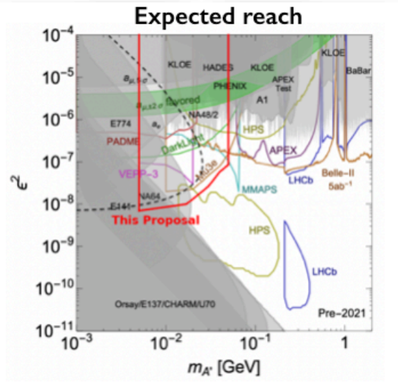
- **Tritium (L.Weinstein)**: *C2, The proposal addresses the fundamental question of the origin of the EMC effect. The physics programme is very rich, but the extraction of the underlying physics observables is very challenging. Therefore the PAC strongly encourages the proponents* ***to reinforce their links with theory groups, in order to benefit from a more complete approach within a full QCD global analysis framework****. The proposal mentions further physics opportunities with exclusive measurements using the same setup and beamtime, and the PAC regards this as an attractive prospect. Once the issues spelled out above have been addressed, the PAC recommends a resubmission* ***as part of a Run-Group Proposal,*** *which will detail all the measurements (e.g. SIDIS, DVCS, exclusive meson production) to be done as part of the A = 3 Nuclei target program with CLAS12.*

Sensitivity Example for $\epsilon^2 = 10^{-6}$

100.0 nA × 30.0 days @ 3.3 GeV



Expected reach



SIDIS Exp

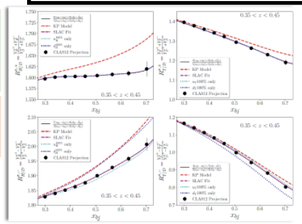
Spokespeople: D. I

- Study Flavor-Dependent EMC Effe
  SIDIS ratios of 3He and 3H $(e,e'$
- In $Z \neq N$ different medium effect on u quark ?
  - ✓ If N>Z, u-quark is more "bound" → ^{3}H
  - ✓ If N<Z, d-quark is more "bound" → ^{3}He

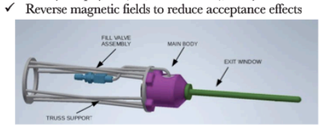
I. Cloet, et al, PRL 109, 182301 (2012); PRL 102, 252301 (2

$$R^{\pi^\pm}_{A_1/A_2}(x,z) = \frac{4(u_{A_1} \pm \bar{u}_{A_1}) \pm (d_{A_1} \pm \bar{d}_{A_1})}{4(u_{A_2} \pm \bar{u}_{A_2}) \pm (d_{A_2} \pm \bar{d}_{A_2})}$$

- ✓ Probe the iso-spin dependence of the EMC effect
- ✓ Directly study the EMC effects of u- and d-quarks in A=3
- ✓ Fragmentation Functions (FFs) should be small and largely cancel in ratios



- Study Strangeness Contents in A=3 with kaons (tl RICH)
- Experimental Settings:
  - ✓ Standard CLAS12 Configuration
  - ✓ Same target system in Tritium-SRC (E12-20-005)
  - ✓ 50 days of physics (D2, H3 and He3), 8 days calibration runs
  - ✓ Reverse magnetic fields to reduce acceptance effects

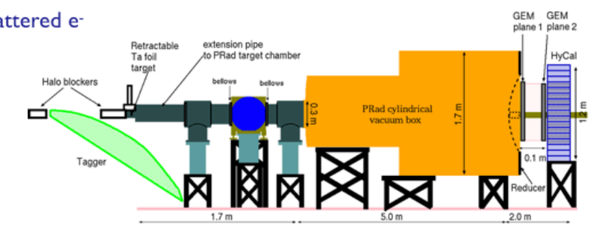


beam background.

- ✓ direct detection of decay particles (e^+e^-) and scattered e$^-$

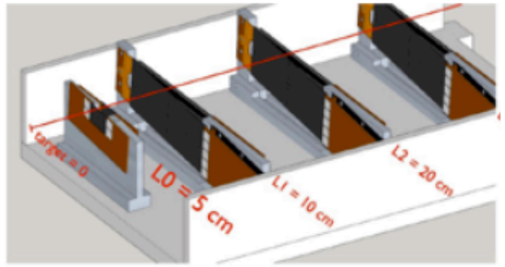
Detection criteria:

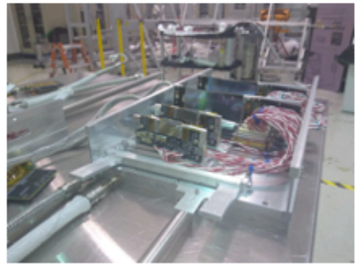
- scattered electron is in the $PbWO_4$ acceptance with E_e = [30MeV to 0.7xE_{beam}];
- decay e$^-$ and e$^+$ are in the $PbWO_4$ within energy: [0.03 – 0.8xE_{beam}]
- Target to PbWO4 distance L=7.5 m beam energy optimized for E_e = 2.2 GeV and 3.3 GeV

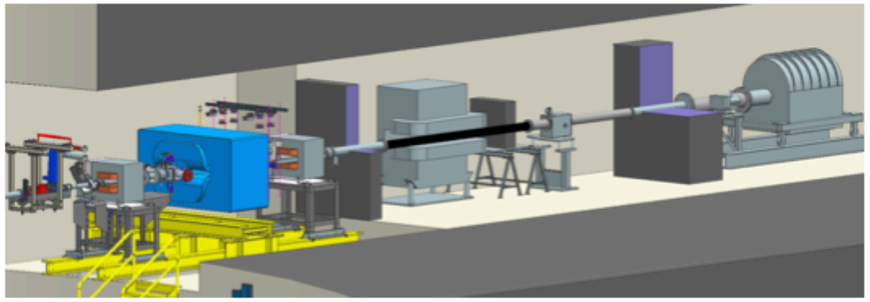


Heavy Photon Search

Hall B







HPS Fall '21 run

- Scheduled for 54 days (27 PAC days) to start in mid August
- Actual: Sept 12 - Nov 5 2021 thanks to one month extension
- Collected 85% of the expected statistics (85% Hall efficiency, ~46% of ABU)
- Still 102 PAC days (over 130 days confirmed by the jeopardy in 2020)

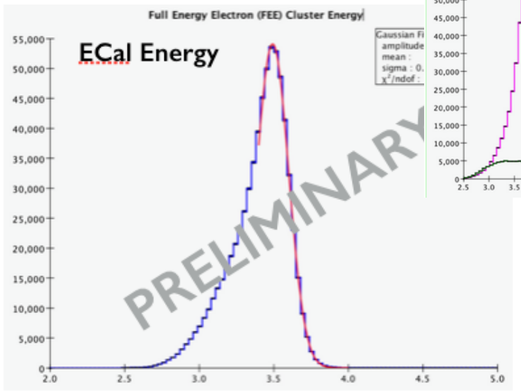
Thanks to whole HPS team for their support (hw, shifts, troubleshooting …)

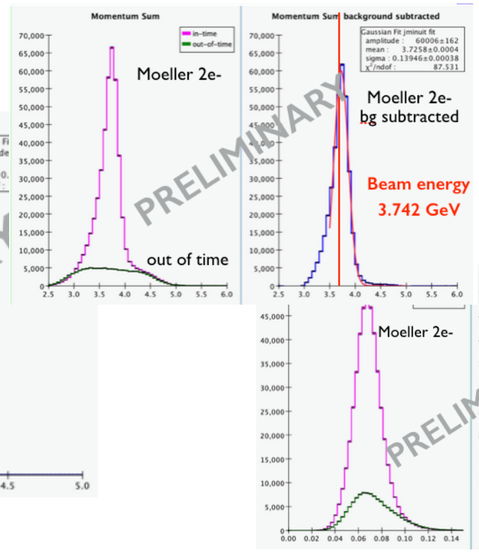
Pass 1 beam

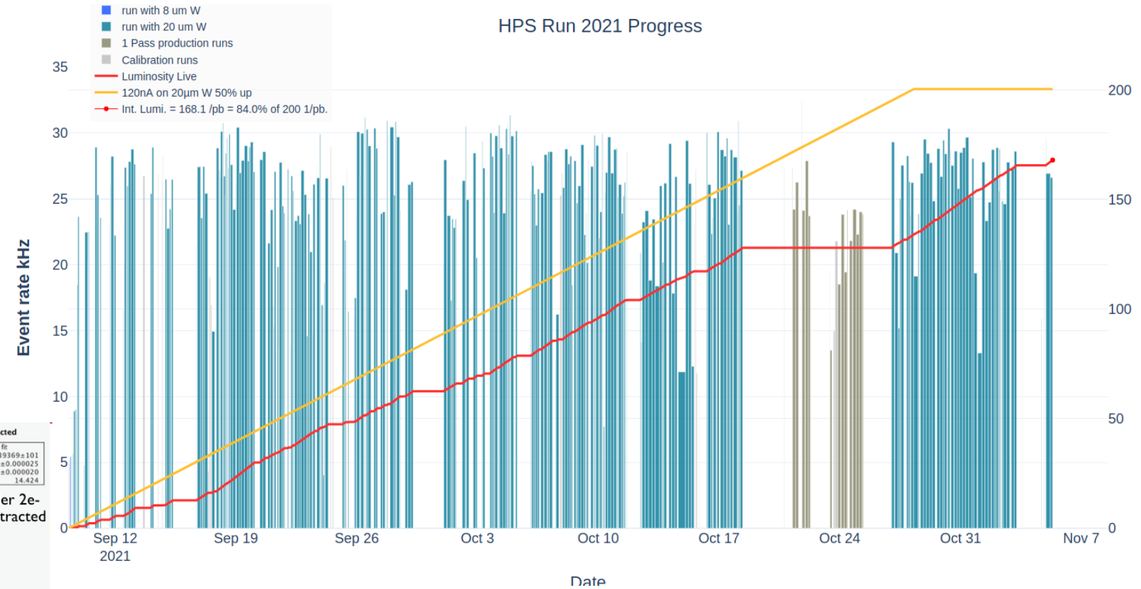
- E_{beam}: 1.92 GeV
- I_{beam}: 70 nA
- Targ: 8 μm W few days

Pass 2 beam

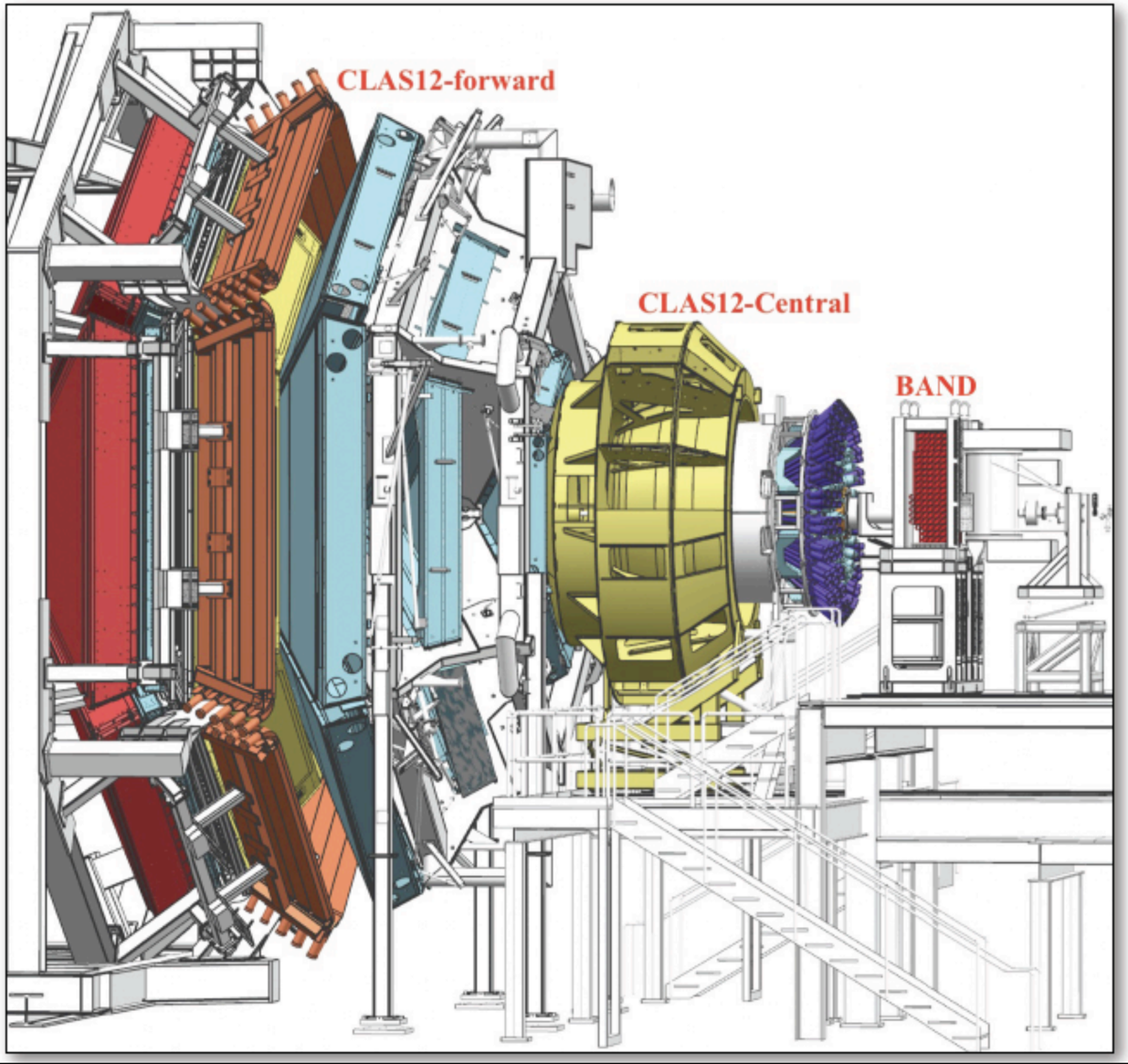
- E_{beam}: 3.74 GeV
- I_{beam}: 120 nA
- Targ: 8, 20 μm W

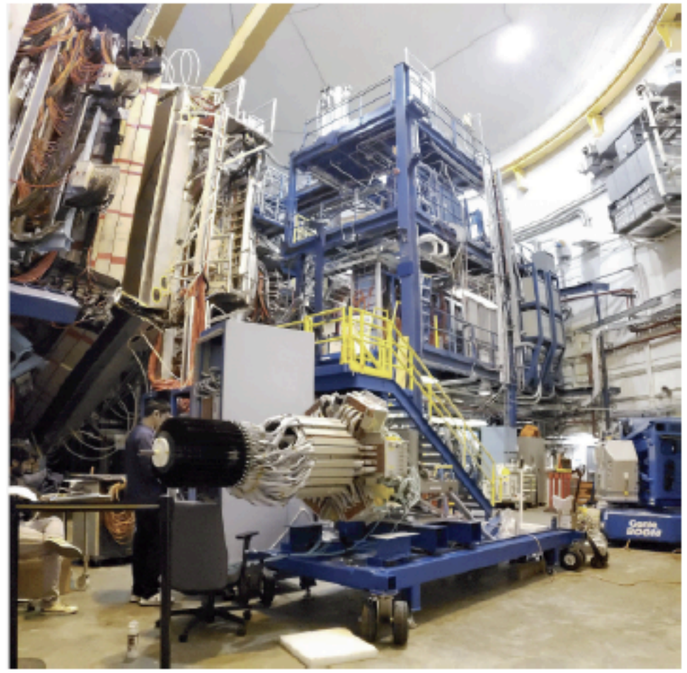


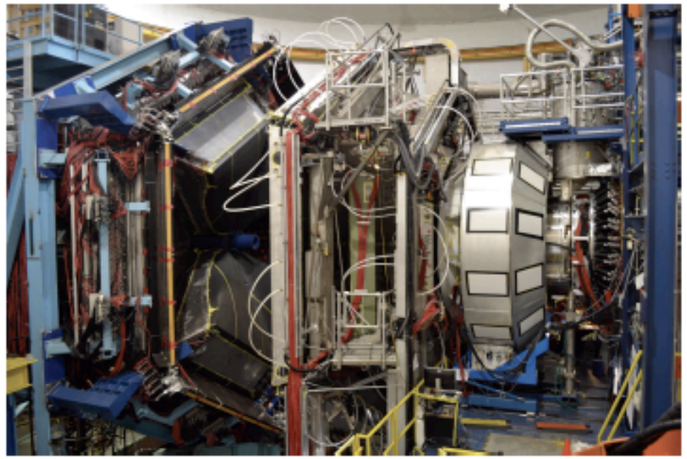


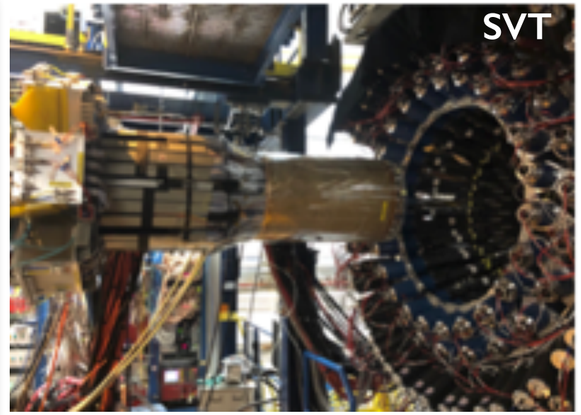


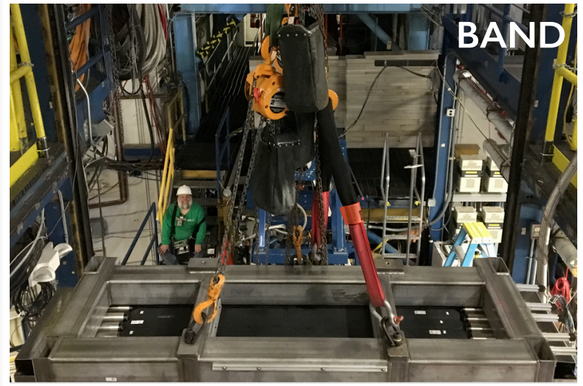
Credit: R.Paremuzyan, S.Stepanyan, N.Graf

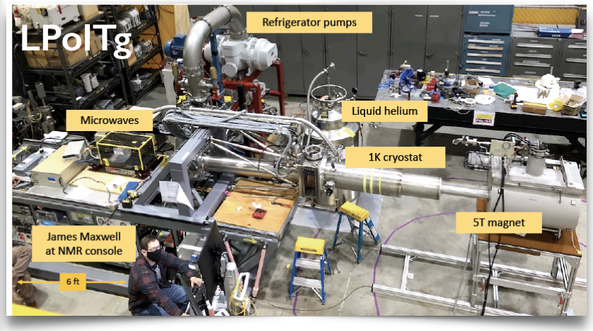

CLAS12-forward
CLAS12-Central
BAND






SVT


BAND


LPolTg
Refrigerator pumps
Microwaves
Liquid helium
1K cryostat
5T magnet
James Maxwell
at NMR console
6 ft

Data processing

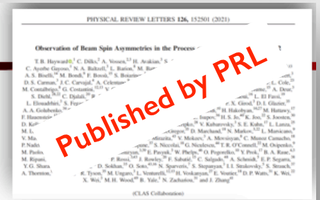
	Calibration status	Cooking status	Timeline for completion
– **Run Group A**: • 13 experiments • 10.2-10.6 GeV polarized electrons • Liquid-hydrogen target • ~300 mC, ~50% of approved beam time	In progress	60% done	Spring 18 calibration in progress ~1-2 months
– **Run Group K**: • 3 experiments • 6.5, 7.5 GeV polarized electrons • Liquid-hydrogen target • ~45 mC, ~12% of approved beam time	Completed	Fully cooked	-
– **Run Group B**: • 7 experiments • 10.2-10.5 GeV polarized electrons • Liquid-deuterium target • ~155 mC, ~43% of approved beam time	Completed	Fully cooked	-
– **Run Group F (BONUS)**: • 1 experiment • 10.2 GeV polarized electrons (+2.2 GeV for calibration) • Gas-deuterium target +RTPC • ~92% of approved beam time	Win20 Sum20	- 60%	calibration in progress Summer '20 ~2 months Winter '20: RTPC data are problematic

Goal: complete the Pass1 reconstruction of the whole RGA/B(/F) data sets before starting Pass2

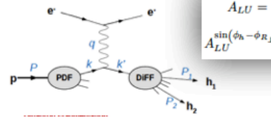
The present: CLAS12 physics program

First Observation of Beam Spin Asymmetries in the Process
e p → e' π⁺ π⁻ X with CLAS12

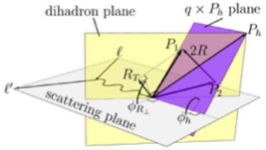
- SIDIS ingredients: q in the nucleon (PDF), hadronization (Fragmentation Functions)
- Fragmentation in 2h is sensitive to *several* TMDs and Dihadron Fragmentation Functions (DiFFs)
- Spin-momentum correlations in hadronization
- Access to PDF e(x) (trans pol. q in a unp nucleon, tw-3) and Dihadron FF G1-perp (helicity of fragmenting q)
- Complement single-hadron SIDIS, with the advantage of another degree of freedom



PI: T.Hayward

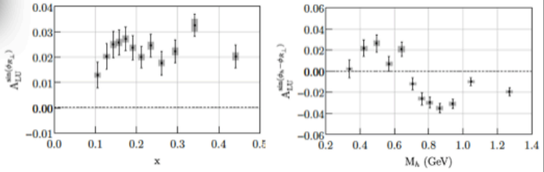


$$A_{LU} = \frac{1}{P_{\text{beam}}} \frac{N^+(\phi_h,\phi_{R_\perp}) - N^-(\phi_h,\phi_{R_\perp})}{N^+(\phi_h,\phi_{R_\perp}) + N^-(\phi_h,\phi_{R_\perp})} = A_{LU}^{\sin(\phi_h-\phi_{R_\perp})} \sin(\phi_h - \phi_{R_\perp}) + A_{LU}^{\sin(\phi_{R_\perp})} \sin(\phi_{R_\perp}),$$



- Ph = P1 + P2 pions 3-mom
- RT is the component of R perpendicular to Ph
- Φh = azimuthal angle of q × Ph plane
- ΦR⊥ = azimuthal angle of di-hadron plane

- e(x)≠ 0 in valence region
- From known H-function, e(x) can be extracted

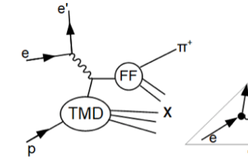


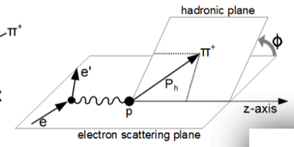
★ First measurement of BSA in di-h production
★ Sub-leading PDF e(x) different from 0
★ First helicity-dep FF G1⊥ observation

CLAS12 publications

First multidimensional, high precision measurements of semi-inclusive π⁺ beam single spin asymmetries from the proton over a wide range of kinematics

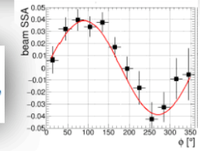
- So far, good mapping of 1D PDF (longitudinal momentum dependence)
- Are the q carrying an orbital angular momentum? how is it connected to the spin of the nucleon? q correlations?
- 3-D structure accessed trough Transverse Momentum dep. Distributions (TMDs)
- Semi Inclusive DIS (SIDIS) to study the transverse structure of the nucleon
- Single Spin Asymmetries (SSA) sensitive to TMDs and Fragmentation Functions (FF)
- Beam SSA: twist-3, subleading, O(M/Q), accessible in fixed target, medium energy (~10 GeV) experiments





$$SSA(z, P_T, \phi, x_B, Q^2) = \frac{d\sigma^+ - d\sigma^-}{d\sigma^+ + d\sigma^-} = \frac{A_{LU}^{\sin\phi} \sin\phi}{1 + A_{UU}^{\cos\phi} \cos\phi + A_{UU}^{\cos 2\phi} \cos 2\phi},$$

$$A_{LU}^{\sin\phi} = \frac{\sqrt{2\epsilon(1-\epsilon)}\, F_{LU}^{\sin\phi}}{F_{UU,T} + \epsilon F_{UU,L}},$$

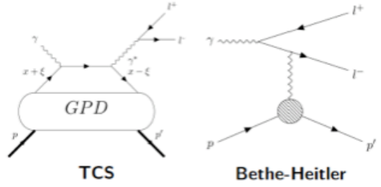


- x_B= proton momentum fraction carried by the struck q
- z = γ_π energy fraction carried by π
- PT = π transverse momentum
- F_{LU} = q-g correlation (genuine tw-3) = Convolution {Collins, Boers-Mulders, tw-3 TMD pol and unpol FF}

The present: CLAS12 physics program

Timelike Compton Scattering

TCS: $\gamma p \to e^+ e^- p'$



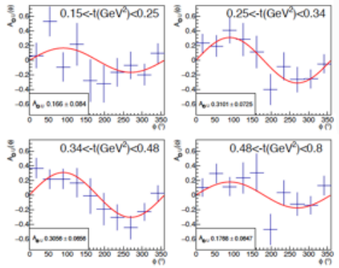
Test of universality of GPDs
- TCS is parametrized by GPDs
- **Comparison between DVCS and TCS** results allows to test the universality of GPDs
- TCS does not involve Distribution Amplitudes unlike Deeply Virtual Meson Production → direct comparison between DVCS and TCS

Real part of CFFs and nucleon D-term
- As for DVCS, TCS unpolarized cross section is sensitive to $Re\mathcal{H}$, which is still not well constrained by existing data.
- The CFFs dispersion relation at leading order and leading twist :

$$Re\mathcal{H}(\xi,t) = \mathcal{P}\int_{-1}^{1} dx \left(\frac{1}{\xi - x} - \frac{1}{\xi + x}\right) Im\mathcal{H}(\xi,t) + D(t)$$

- $D(t)$ can be related to the mechanical properties of the nucleon.

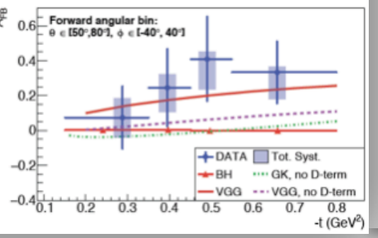
Review in Polyakov, Schweitzer, *International Journal of Modern Physics A*, 2018



PI: P.Chatagnon

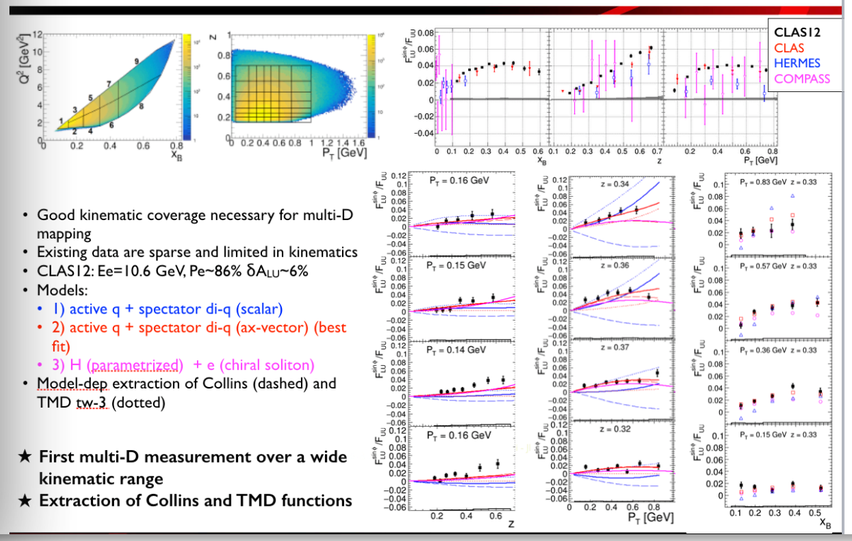
$$BSA = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-} = \frac{\sin\phi \; Im\tilde{M}^{--}}{d\sigma_{BH}}$$

- **First measurement ever!**
- **Sizeable Asymmetry**
- **Good agreement with GPD model fit to DVCS**



Credit: P.Chatagnon, S.Diehl, T.Hayward, S.DiehlLatifa E.

CLAS12 publications



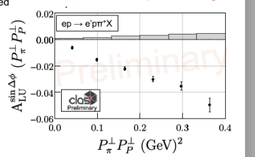
- Good kinematic coverage necessary for multi-D mapping
- Existing data are sparse and limited in kinematics
- CLAS12: Ee=10.6 GeV, Pe~86% δA_{LU}~6%
- Models:
  - 1) active q + spectator di-q (scalar)
  - 2) active q + spectator di-q (ax-vector) (best fit)
  - 3) H (paramerized) + e (chiral soliton)
- Model-dep extraction of Collins (dashed) and TMD tw-3 (dotted)

★ **First multi-D measurement over a wide kinematic range**
★ **Extraction of Collins and TMD functions**

BACK-TO-BACK EP→E'Π⁺P BSA
TIMOTHY B. HAYWARD, HARUT AVAKIAN

- TMDs have been studied via azimuthal modulations of a hadron generated in the fragmentation of a struck quark (CFR). However, hadrons can also form from the left-over target remnant (TFR) whose partonic structure is defined by "**fracture functions**": the probability to form a certain hadron given a particular ejected quark.
- Significant single-spin asymmetries have been observed **for the first time** in back-to-back electroproduction where a proton is produced in the TFR and a pion is produced in the CFR. This measurement is the **first signal sensitive to a TMD fracture function**.
- **Analysis note submitted and has progressed through the first stage of correspondence with the review committee.** Follow up expected within < 2 weeks.
- Paper draft in progress

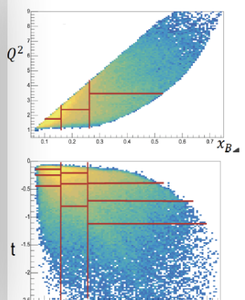
Structure function depends on the unmeasured fracture function, , and the well measured unpolarized dihadron fragmentation function,

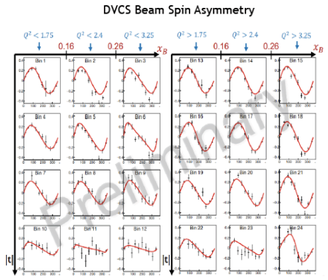


$P_\pi^\perp P_P^\perp$ (GeV)^2

Figure 1: Lepto-production of two hadrons, one in the CFR and one in the TFR.

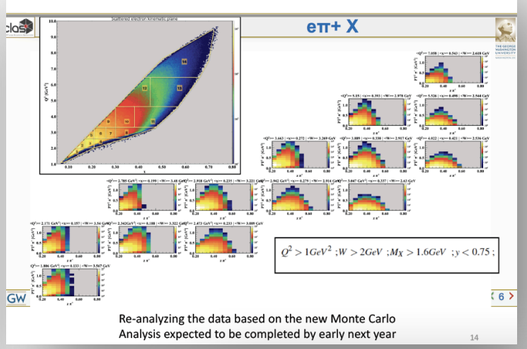
RGA - DEEP EXCLUSIVE HIGHLIGHTS
M. Defurne et al.





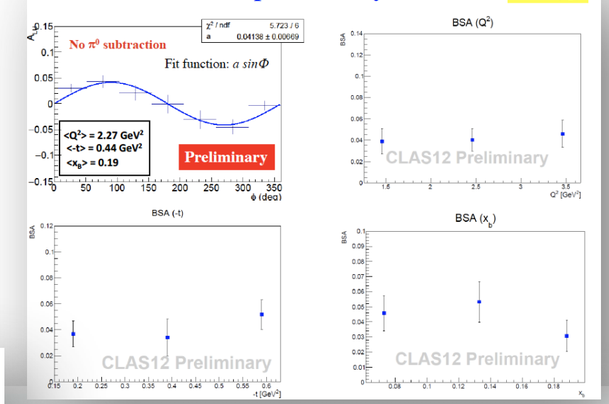
Analysis note completed and submitted to the PWG- First round of questions and recommendations by the review committee received.

G. Angelini



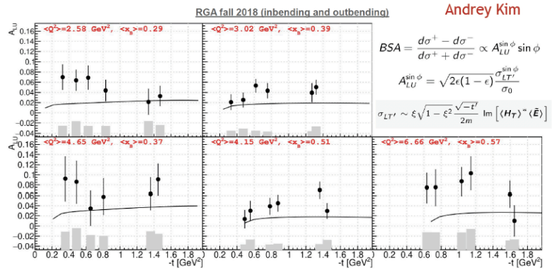
Re-analyzing the data based on the new Monte Carlo
Analysis expected to be completed by early next year

nDVCS: preliminary raw BSA
ed→enγ(p)



Beam spin asymmetry for deeply virtual π^0 production
Andrey Kim

RGA fall 2018 (inbending and outbending)



$$BSA = \frac{d\sigma^{\uparrow} - d\sigma^{\downarrow}}{d\sigma^{\uparrow} + d\sigma^{\downarrow}} \propto A_{LU}^{\sin\phi}\sin\phi$$

$$A_{LU}^{\sin\phi} = \sqrt{2\epsilon(1-\epsilon)}\frac{\sigma_{LT'}^{\sin\phi}}{\sigma_0}$$

$$\sigma_{LT'} \sim \xi\sqrt{1-\xi^2}\frac{\sqrt{-t'}}{2m}\,\mathrm{Im}\left[(H_T)^*\tilde{(E)}\right]$$

- Sizable Beam Spin Asymmetry measurements suggest significant contributions from chiral-odd GPDs
- Experimental BSA measurements provide necessary constraints for chiral-odd GPD parameterizations
- Analysis note in final stage of preparation (Cross check)

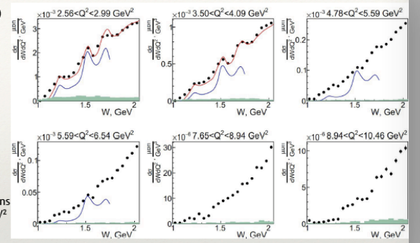
Inclusive Cross Sections with CLAS12

preliminary CLAS12 data (stat. errors)

systematic uncertainties

interpolation of the previous CLAS results, A.A. Golubenko et al., Prog. Part. Nucl. 50, 587 (2019)

resonant contribution computed with $\gamma_v pN^*$ electrocouplings from CLAS meson electroproduction data, A.N. Hiller Blin et al., PRC,104 025201 (2021)



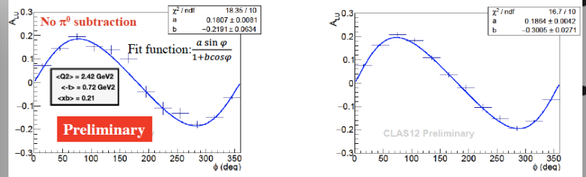
- First results on (e,e'X) inclusive cross sections in the resonance region at Q^2 from 4-10 GeV^2 with a broad coverage over W in any Q^2-bin
- Evaluated resonant contributions pave the way to probe the nucleon PDF in the resonance region and open up new opportunities to explore quark hadron duality
- Studies of inclusive structure function moments within a broad range of Q^2<10 GeV^2 will shed light on the twist decomposition of the (e,e'X) inclusive process and possibly also on the role of gluons in the nucleon PDF evolution at large values of x in the resonance region

Timeline:

- MC: Nov – Feb
- Analysis: Nov - Apr
- Systematic Errors: Dec - Apr
- Analysis Note: Nov - Apr
- Analysis Note ready by May 2022

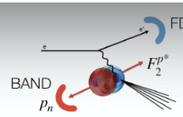
Sanity check (and more): pDVCS on deuterium
ed→epγ(n)

Interest of pDVCS on deuterium:
- In itself: nuclear medium effects on proton structure
- To evaluate FSI for nDVCS, comparing to free pDVCS
- To validate the BSA analysis on nDVCS

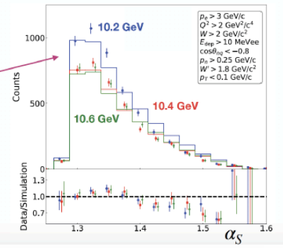


- Raw BSA integrated over all kinematics and detection topologies
- **Compatible with raw BSA from pDVCS in RGA, no evidence of medium effects at this stage**
- Work on π^0 subtraction underway

BAND Update



- **Goal**: Study origin of EMC effect by tagged DIS measurement
- **Observable**: $R_{tag} = \frac{\sigma_{tag}^{exp}(Q^2, p_T, \alpha_S, x') / \sigma_{tag}^{exp}(Q^2, \alpha_S, x' = x_0)}{\sigma_{tag}^{PWIA}(Q^2, p_T, \alpha_S, x') / \sigma_{tag}^{PWIA}(Q^2, \alpha_S, x' = x_0)} \sim \frac{F_2^{p*}}{F_2^p}$
- Analysis status
  - good agreement of data and MC
  - systematic studies underway
  - BAND calibration note finished
  - analysis note in progress



Status of J/psi analysis

- Data Set
  - In-Bending Fall 2018
  - In-Bending Spring 2019
  - If available use Spring 2018 data
- Beam energy
  - 10.6 GeV and and 10.2 GeV

The goal
- -t dependence of the differential cross-section
- Total cross-section as a function of photon energy

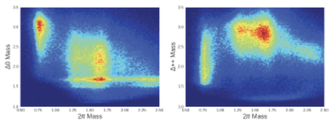
The plan is to use BH for normalization of the measured cross section $\omega_c = \frac{n_{BH}^d}{\mathcal{N}_\gamma \cdot n_T} \times \frac{n_{BH}^G}{n_{BH}^R} \times \frac{1}{\sigma_{BH}}$

- Systematics: The machinery of calculating systematics is ready
  - Effect of the exclusivity cuts
  - Effect of TMVA cut value on e⁺ selection.
  - -t slope in the generator
  - Yield extraction method:
  - Fitting the t_slope vs total number of detected events
  - Binning effect
- Next steps
  - ~~Complete the cross-check~~ done
  - Finalize the normalization

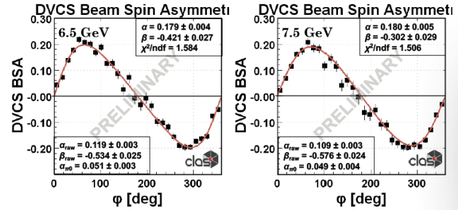
Some more work is needed to control the normalization.

Analysis to be finished by Spring 2022

Meson X



DEEPLY VIRTUAL COMPTON SCATTERING AT 6.5 GEV AND 7.5 GEV POLARIZED ELECTRON BEAM WITH CLAS12

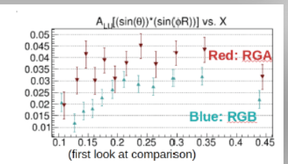


Integrated DVCS BSA after π^0 contaminant subtraction.
Analysis note in draft form – expected to be submitted to the PWG January 2022.

22

$ep \to e\pi^+\pi^- X$ vs. $eD \to e\pi^+\pi^- X$

- Compare A_{UU} of $\pi^+\pi^-$ from proton and deuteron targets (RGA and RGB)
- Access flavor dependence of twist-3 PDF e(x)
- Plan to do a full partial wave fit
- Status: refining cuts for RGB; may need joint discussions between RGA and RGB
- RGA preliminary results released April 2021; No preliminary results yet for RGB

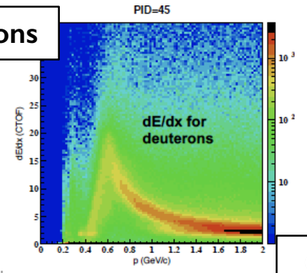


CLAS12 data calibration and efficiency

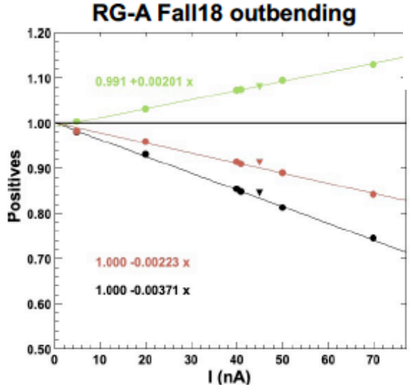
PASS2 data cooking

- Reprocessing of proton and deuteron target data with improved reconstruction, calibration, alignment and field map (including AI-supported algorithms)
- Involves already processed RGA, RGB and RGK data
- Provides improved data quality to enable maximum physics output

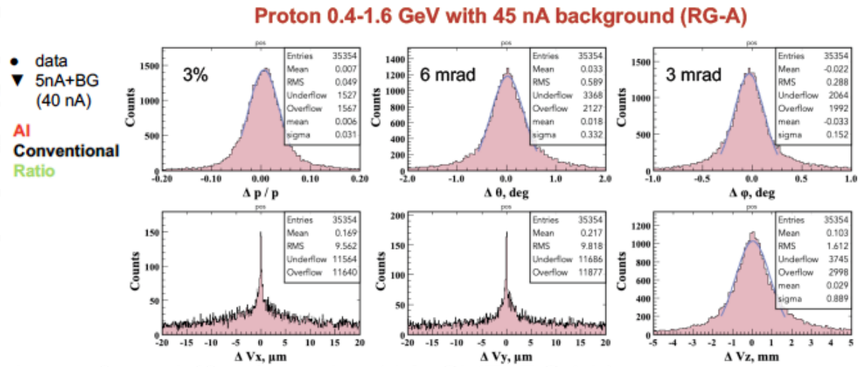
EB: dE/dx for hadrons



AI-Assisted tracking



CVT reconstruction and alignement

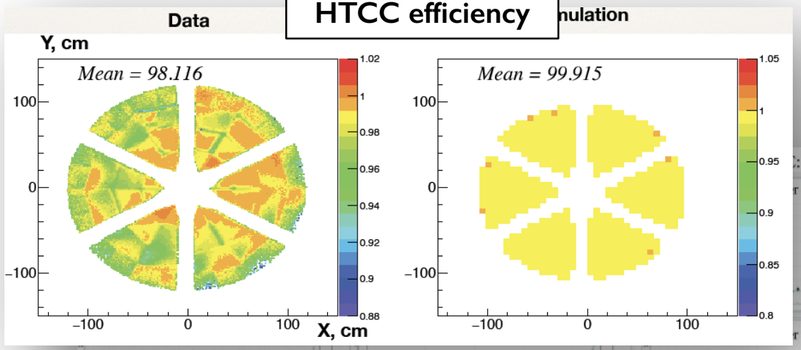


- Significant progress toward pass2 in difficult tasks (AI, CVT, ECAL)
- Prioriries for work to do:
  - Reconstruction: CVT, DC and RICH
  - Alignment: CVT and RICH
- Other tasks are less critical
- Couple of months expected (target: end of December)

CLAS12 efficiency

- Absolute cross sections require good understanding of CLAS12 acceptance
- From simulation/data comparison extract corrections
- Efficiency is time-dependent: detector performance, GEMC, rec sw
- GEMC and REC sw tuning in progress: thresholds, status tables to account for malfunctioning elements, fiducial cuts, QA
- Rad corrections
- Sanity checks: comparison with known cross sections (CLAS6 et al), with different extractions

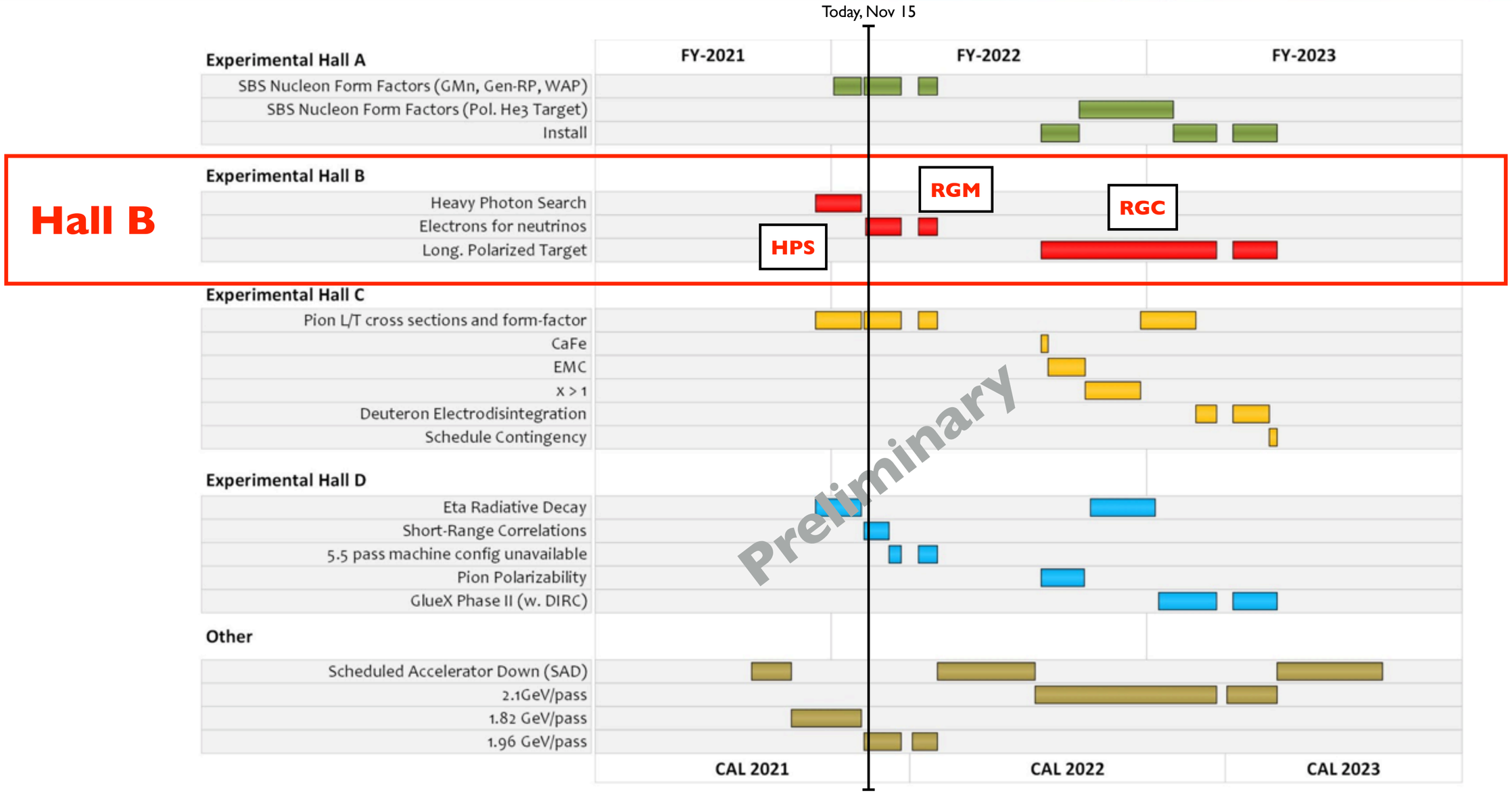
HTCC efficiency



DC efficiency
GEMC tuning

Credit: R. De Vita, N.Markov, D.Carman, F.Hauenstein

Scheduling


Today, Nov 15
FY-2021
FY-2022
FY-2023
Experimental Hall A
SBS Nucleon Form Factors (GMn, Gen-RP, WAP)
SBS Nucleon Form Factors (Pol. He3 Target)
Install
Hall B
Experimental Hall B
Heavy Photon Search
Electrons for neutrinos
Long. Polarized Target
RGM
RGC
HPS
Experimental Hall C
Pion L/T cross sections and form-factor
CaFe
EMC
x > 1
Deuteron Electrodisintegration
Schedule Contingency
Experimental Hall D
Eta Radiative Decay
Short-Range Correlations
5.5 pass machine config unavailable
Pion Polarizability
GlueX Phase II (w. DIRC)
Other
Scheduled Accelerator Down (SAD)
2.1GeV/pass
1.82 GeV/pass
1.96 GeV/pass
CAL 2021
CAL 2022
CAL 2023
Preliminary

Scheduling - winter 21/22

- RG-M installation; Wed Nov 10 start RG-M 6.0 GeV (~200 nA)

RG-M: 31/45 PAC DAYS

- RG-M stop for Xmass break on Tuesday Dec 20

- Mon January 31 2022: Acc OFF

	A	B	C	D	E	F	G	H
93	11/08/21	Monday	1.96	Physics	E12-09-019	4.0/40/-/500		
94	11/09/21	Tuesday	1.96	Physics	E12-09-019	4.0/40/-/500		
95	11/10/21	Wednesday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
96	11/11/21	Thursday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
97	11/12/21	Friday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
98	11/13/21	Saturday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
99	11/14/21	Sunday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
100	11/15/21	Monday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
101	11/16/21	Tuesday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
102	11/17/21	Wednesday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
103	11/18/21	Thursday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
104	11/19/21	Friday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
105	11/20/21	Saturday	1.96	Physics	E12-09-019	4.0/40/-/500	Run Group M	6.0/200/-/500
130	12/15/21	Wednesday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
131	12/16/21	Thursday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
132	12/17/21	Friday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
133	12/18/21	Saturday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
134	12/19/21	Sunday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
135	12/20/21	Monday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
136	12/21/21	Tuesday						
137	12/22/21	Wednesday						
138	12/23/21	Thursday						
156	01/10/22	Monday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
157	01/11/22	Tuesday	1.96	Physics	E12-09-019	4.0/40/p/500	Run Group M	6.0/200/-/500
169	01/23/22	Sunday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	2.1/200/-/500
170	01/24/22	Monday	1.96	Physics	E12-09-019	6.0/40/p/500	PASS CHANGE	
171	01/25/22	Tuesday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	4.0/200/-/500
172	01/26/22	Wednesday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	4.0/200/-/500
173	01/27/22	Thursday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	4.0/200/-/500
174	01/28/22	Friday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	4.0/200/-/500
175	01/29/22	Saturday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	4.0/200/-/500
176	01/30/22	Sunday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	4.0/200/-/500
177	01/31/22	Monday	1.96	Physics	E12-09-019	6.0/40/p/500	Run Group M	4.0/200/-/500
178	02/01/22	Tuesday						
179	02/02/22	Wednesday					WINTER/SPRING SCHEDULED ACCELERATOR DOW	
180	02/03/22	Thursday						

Scheduling - 2022

- Wednesday June 1st: RG-C will start

RG-C
120/120 PAC DAYS
- 4 CalDays 2.2 GeV
- 52 CD 10.6 GeV FT-ON
- 139+45 CD10.6 GeV FT-OFF

- Wednesday Dec 21 2022 Acc OFF

- Monday January 9 2023: RG-C restart

- Tuesday February 28 2023: RG-C last day

191	5/31/2022	Tuesday	2.1	Restore					
192	6/1/2022	Wednesday	2.1	Physics	Install		Run Group C	2.2/200/p?/500	
193	6/2/2022	Thursday	2.1	Physics	Install		Run Group C	2.2/200/p?/500	
194	6/3/2022	Friday	2.1	Physics	Install		Run Group C	2.2/200/p?/500	
195	6/4/2022	Saturday	2.1	Physics	Install		Run Group C	2.2/200/p?/500	
196	6/5/2022	Sunday	2.1	Physics	Install		PASS CHANGE		
197	6/6/2022	Monday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	
198	6/7/2022	Tuesday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	
199	6/8/2022	Wednesday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	
200	6/9/2022	Thursday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	
201	6/10/2022	Friday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	
202	6/11/2022	Saturday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	
203	6/12/2022	Sunday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	
204	6/13/2022	Monday	2.1	Physics	Install		Run Group C/FT_ON	10.6/200/p/250	

392	12/18/2022	Sunday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
393	12/19/2022	Monday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
394	12/20/2022	Tuesday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
395	12/21/2022	Wednesday							

414	1/9/2023	Monday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
415	1/10/2023	Tuesday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
416	1/11/2023	Wednesday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
417	1/12/2023	Thursday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	

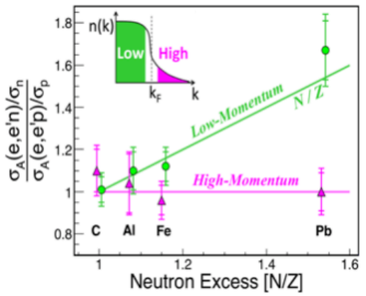
459	2/23/2023	Thursday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
460	2/24/2023	Friday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
461	2/25/2023	Saturday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
462	2/26/2023	Sunday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
463	2/27/2023	Monday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
464	2/28/2023	Tuesday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250	
465	3/1/2023	Wednesday							
466							SPRING SCHEDULED ACCELERATOR DOWN		
467									
468									
469	7/1/2023	Saturday		Physics					

July 1 2023: Restart Physics! Nuclear target runs (RGD, RGE, RGL) and low energy LH2 (RGK)

Fall 2021: RG-M

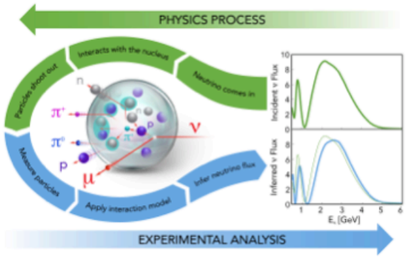
Short Range Correlations

- Build on the tremendous success of the CLAS6 data mining SRC program (Science, several Nature, …)
- Take far more (e,e'pN) and (e,e'pNN) data on a wider range of nuclei
  - Three nucleon SRCs?
  - Constraining the NN interaction at short distances
  - Understanding factorized effective theories
  - SRC formation mechanisms
  - SRCs and the EMC Effec



Electrons for neutrinos

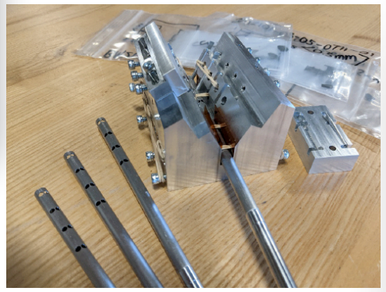
- Take (e,e'X) data to test vector-current part of neutrino-nucleus event generators
  - Energy reconstruction techniques
  - Event generators key to reconstructing oscillation parameters

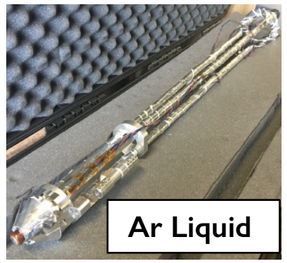


Credit: V.Kubarovsky, B.Miller, C.Wiggins

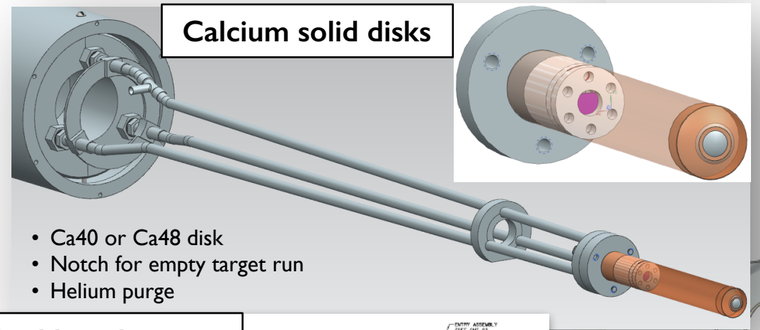
- RG-M support Task force (PI: V.Kubarovsky)
- CLAS12 configuration completed: No FT, no LTCC, TORUS in-bending and out-bending
- FT off (extra shielding), LTCCs are empty, added a vacuum pipe downstream of the target to reduce bg
- CVT, BAND, FMT (3 planes) installed
- Targets: all done but Ca target (used in Hall-A is contaminated).
- Electron trigger fully simulated and parameters established. DC roads ready and tested off-line
- Torus field: Full inb. @ 4.4,6.6 and 0.5 @ 2.2GeV (maximized physics signals from MC simulations)
- Calibrating set of engineering runs from RG-A with different solenoid, beam, and torus field strengths which are relevant to RGM . Now at the last stage of calibration (*in coordination with CALCOM*). Calibration plan ready.
- Off-line monitoring scripts being developed for looking at preliminary physics.

1. Standard Liquid Target with 5 cm Long Cell
   - LH, LD2, LHe
2. Calcium Solid Disk
   - Ca40, Ca48
3. Carbon and Tin Foils in Parallel
   - 4 carbon foils in series, 0.5 mm thick
   - 4 tin foils in series, 70 microns thick
4. Argon Liquid Target with 5 mm Long Cell
5. Carbon Foil
   - 1 carbon foil, 2 mm thick





Ar Liquid

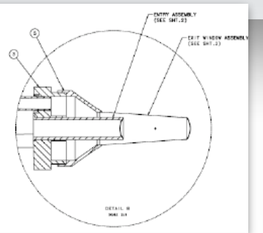


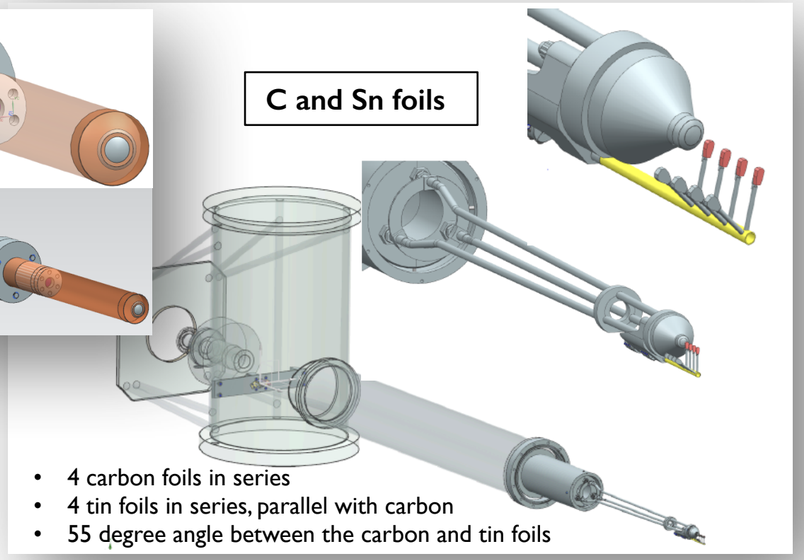
Calcium solid disks

- Ca40 or Ca48 disk
- Notch for empty target run
- Helium purge

Standard liquid target

- Standard CLAS12 Saclay Target Cell
- Used for RGA, RGB, RGK





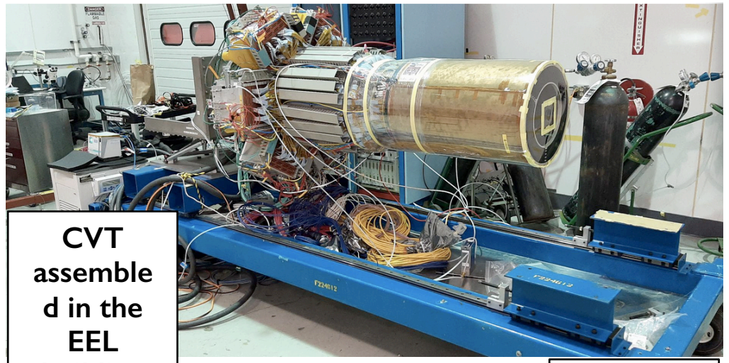
C and Sn foils

- 4 carbon foils in series
- 4 tin foils in series, parallel with carbon
- 55 degree angle between the carbon and tin foils

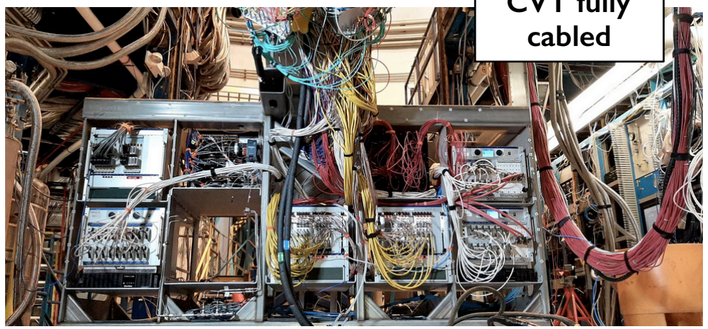
RG-M preparation: SVT + BAND

- Switched back from BONUS configuration to RG-M
- SVT/BMT assembled in EEL building
- Moved to the Hall, cabled and cunder commissioning with comics
- Many thanks to JLab team + Sacly team for continuous (remote) support!

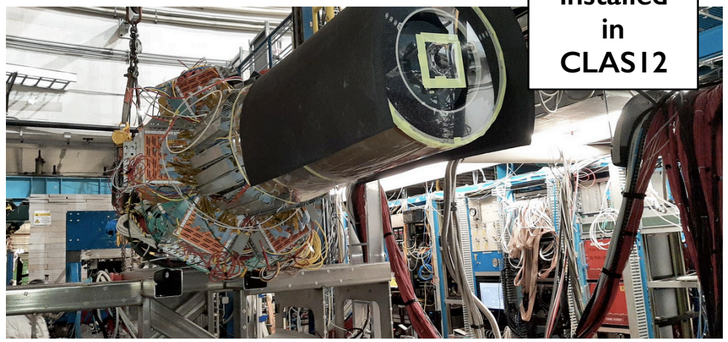
- BAND back on SVT cart
- Successfully cabled (errors found and corrected)
- Survey done
- BAND installed in CLAS12
- BAND cosmics Checkout
- BAND laser system reinstalled (time-walk, offset calibration)



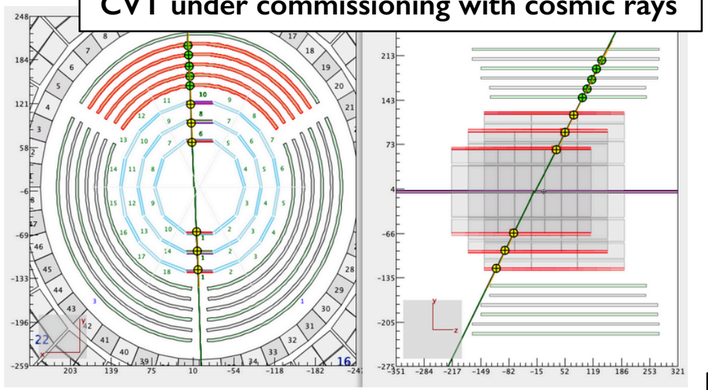
CVT assembled in the EEL building



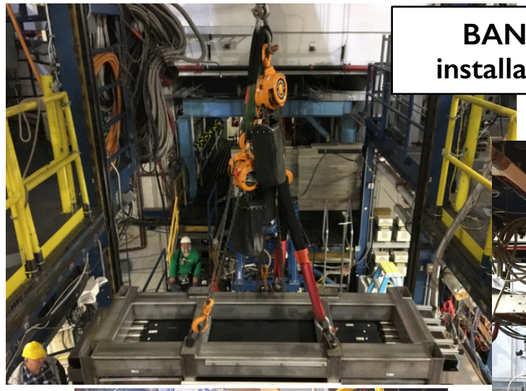
CVT fully cabled



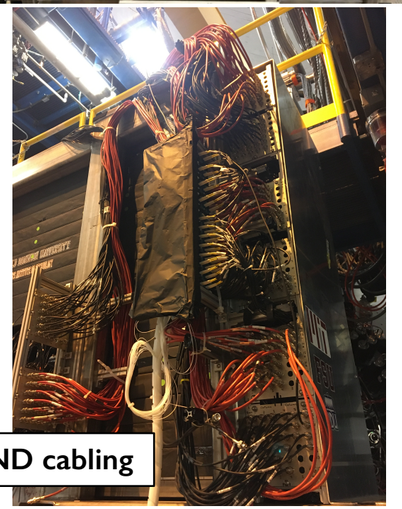
CVT installed in CLAS12



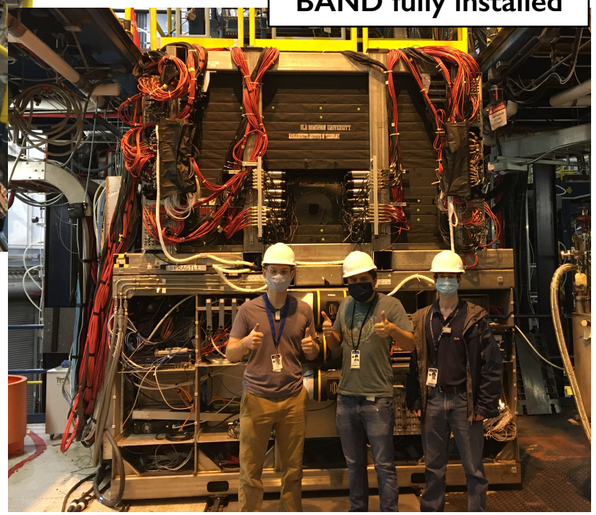
CVT under commissioning with cosmic rays



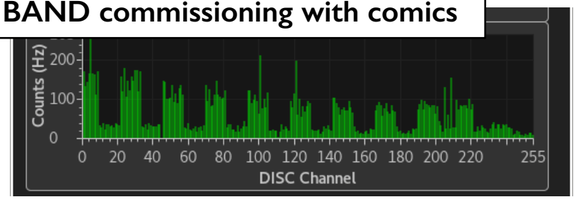
BAND installation



BAND cabling



BAND fully installed



BAND commissioning with comics

Credit: Y.Gotra, R.Paremuzyan + Saclay team

Credit: V.Kubarovsky, B.Miller, C.Wiggins

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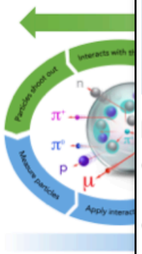

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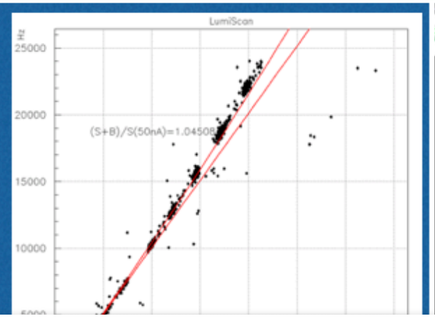
4. Argon Liquid Target with 5 mm Lon Cell
5. Carbon Foil
   - 1 carbon foil, 2 mm thick

Hall-B Meeting, November 15, 2021

RG-M status - Nov 15 2021

- Luminosity scan to optimize running conditions
- I_{beam}=50nA
- R_{DAQ} = 50 kHz
- LT = 96.5%
- Trigger: DC rods IN

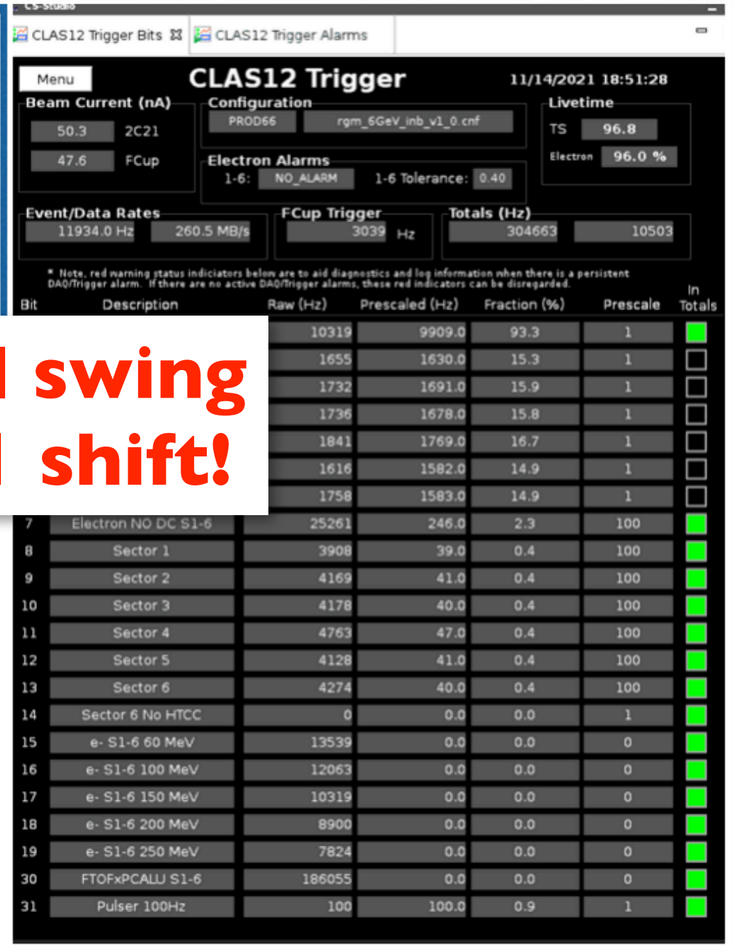
V.Kubarovsky



RGM in full swing after just 1 shift!

RC report (see Stepan's RC repo

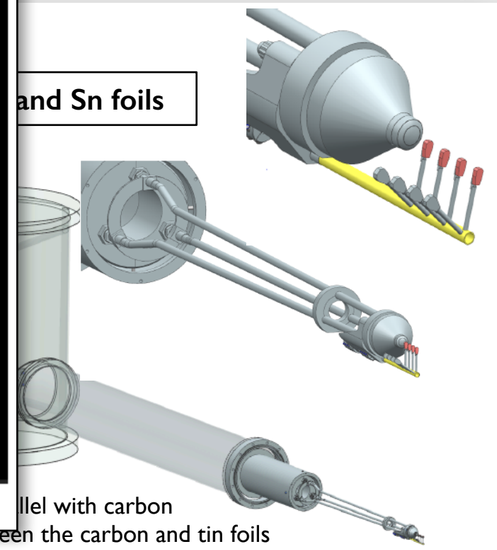
- Beam delivery started on Wednesday at cup at 3:30pm
- Beam centering, luminosity scan on the LH2 target, found the optimum current based on the DC R1 occupancy at I=45 nA
- Trigger validation till midnight, and then PROD mode
- This is a remarkable achievement as we did not run CLAS12 for more than a year and could start data taking after one shift we got a beam in the hall
- At 3:30 am on Thursday the solenoid ramped down, controlled access at 7 am to address the issue. Fixed the solenoid as well as CTOF, HTCC, and DAQ crates. Work in the hall completed by 9 am.
- Continued with PROD till Friday at 10 am. Acc took a time to get a 4-pass separator going for Hall-A.
- Switched to deuterium, Beam back on Faraday cup at 5 pm, PROD on deuterium at 40 nA
- On Saturday DC roads fully validated and in eluded in the trigger
- On Sunday, after luminosity scan increased beam current to 50 nA. LD2 run will continue till the end of the week.



…ending
…he target to reduce bg

…tested off-line
…MC simulations)
… torus field strengths which are …M). Calibration plan ready.

…and Sn foils



…llel with carbon
- 55 degree angle between the carbon and tin foils

Experiments will use longitudinally polarized NH3/ND3 target

E12-06-109	Longitudinal Spin Structure of the Nucleon	Kuhn	A	80	185	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					

RGC: - Originally approved for 185 days of beam time
PAC48-Jeopardy: - Reduced beam time to 120 days w/ focus on DVCS (proton, neutron)
- For remaining beam time return to PAC with new impact study
- Emphasizes availability of Forward Tagger

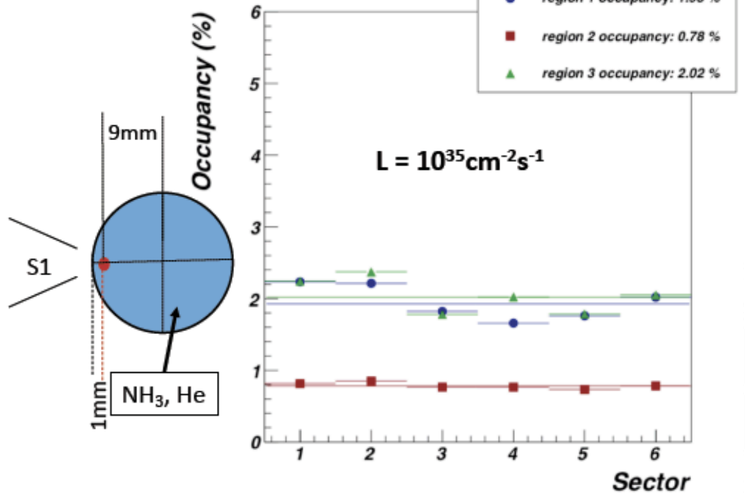
Experiment expected to run summer/fall/winter 2022/2023

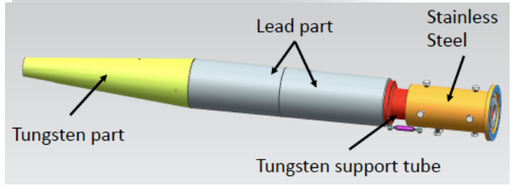
2 configurations:

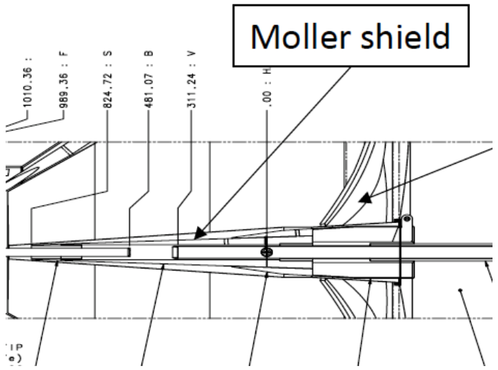
Forward Tagger – IN/ON Measure forward angles, small Q^2
Forward Tagger – OUT Replace FT with new Moller cone

FT-OUT

New target geometry
Raster = 0.9 cm







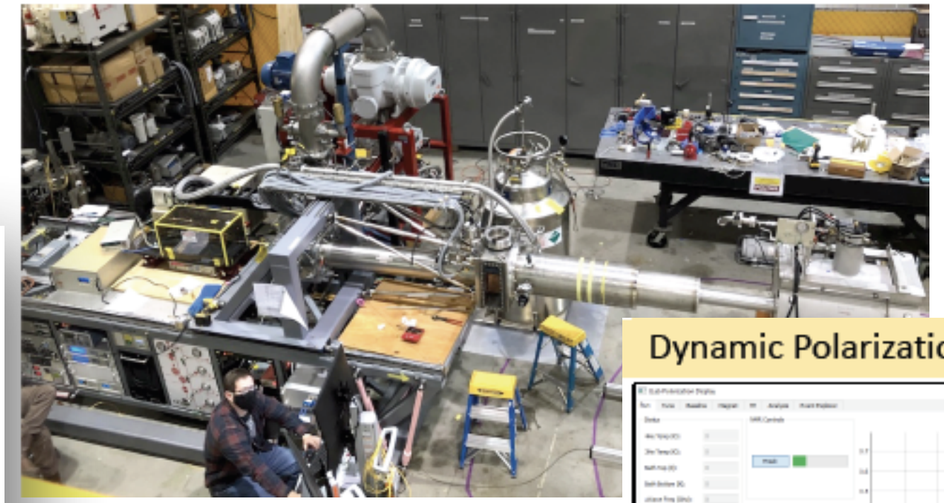
Modified target geometry close to optimal – use this for cone design

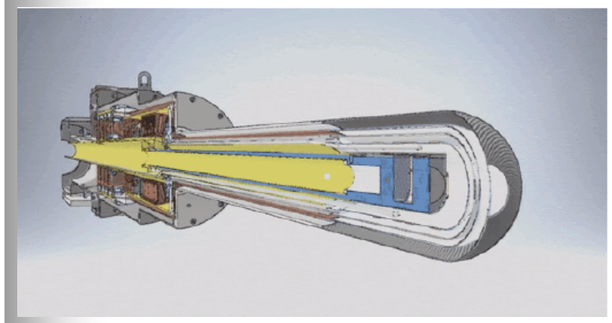
RGC experimental configuration (RGC TF)

- FT-OUT: expected to run at similar L of RGA with new Moller shielding, optimised target geometry
- FT-ON: use same RGA Moller cone; reduced raster size and L/2 (FT-Cal dose sustainable - 2x RG)

Raster (FastElectronic Group +E.Pasyuk, N.Baltzell)

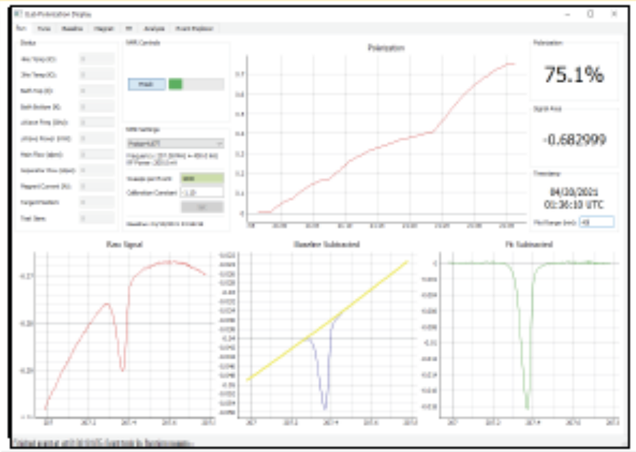
- New raster (spiral, constant linear speed) tested in Hall-B





Credit: C.Keith, V.Burkert, E.Pasyuk

Dynamic Polarization - Irradiated NH_3



Butanol reached +87% in about 50 minutes

Spring 2022: RICH-II

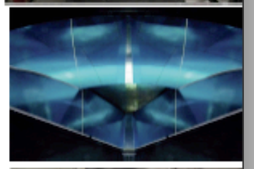
MAPMTs Hamamatsu H12700 MAPMT *(made in Japan)*
391 Hamamatsu MAPMTs, 8x8 matrix, 25024 pixels in total, 1 m² are at Jlab. Characterization completed. Quality is extraordinary (gain, quantum efficiency, dark current)

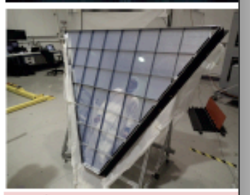
Planar Mirrors: *10 plane mirrors (Italy) are at Jlab small clean room.*
Spherical Mirrors: 8 out of 10 *mirrors produced (U.S.A.)*
2 mirrors are at Jlab for quality assurance. Next step – coating (ECI, USA)

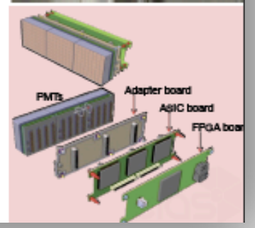
Aerogel *(made in Russia)*
2 cm tiles are completed, delivered to Jlab and stored in the new dry cabinet in big Clean room. 3 cm tiles ready for shipping to U.S.A.

Mechanics *(made in Italy)*
Two boxes with almost all mechanical parts arrived to Jlab. Working on complements. Gas tightness of the electronic panel will be improved by using gaskets with glue.

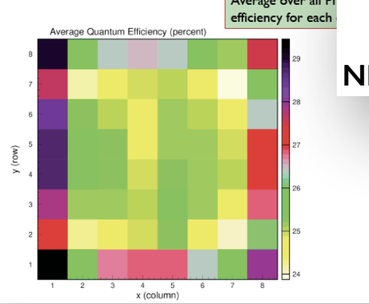
Electronics *(made in Italy, USA, Jlab)*
Most of the front-end panels are at Jlab, 20% MAROC tiles need rework. Expect to finish in October.
DAQ and services DAQ boards on site. CAEN LV, HV delivered. Fiber optics delivered. FPGA boards expected in October.







Average Quantum Efficiency

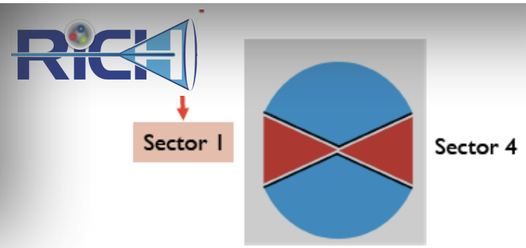


Characterization of Multianode Photomultiplier Tubes for use in CLAS12 RICH Detector

P. Degtiarenko[a], A. Kim[b,*], V. Kubarovsky[a], B. Raydo[a], A. Smith[c]

[a] *Jefferson Lab, Newport News, Virginia, USA*
[b] *University of Connecticut, Storrs, CT 0626, USA*
[c] *Duke University, Durham, NC 2770, USA*

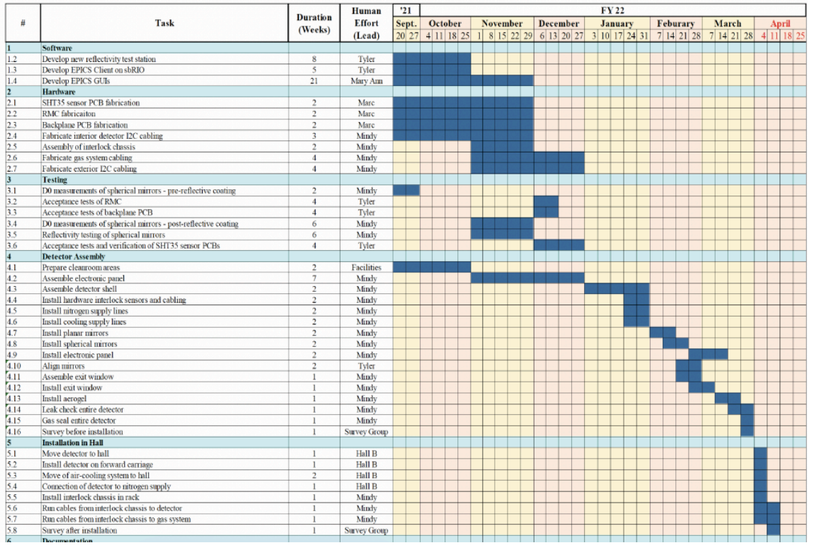
NIM in preparation



Credit: V.Kubarovsky

The final goal is to be ready by May 2022

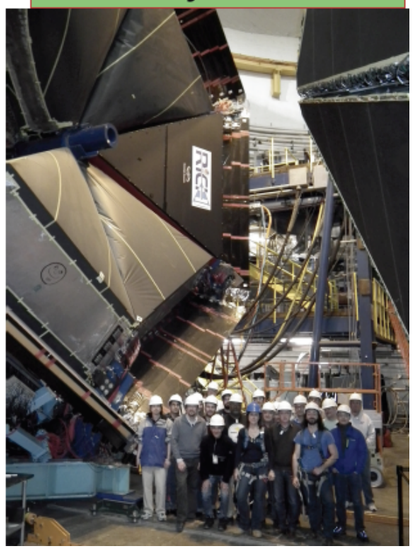
- Active involvement and support of FastElectronic Group (readout boards), DSG (mirror characterisation)
- Clean room preparation for RICH-II assembly
- Detailed plan prepared



#	Task	Duration (Weeks)	Human Effort (Lead)
1	**Software**		
1.2	Develop new reflectivity test station	8	Tyler
1.3	Develop EPICS Client on sbRIO	5	Tyler
1.4	Develop EPICS GUIs	21	Mary Ann
2	**Hardware**		
2.1	SHT35 sensor PCB fabrication	2	Marc
2.2	RMC fabrication	2	Marc
2.3	Backplane PCB fabrication	2	Marc
2.4	Fabricate interior detector I2C cabling	3	Mindy
2.5	Assembly of interlock chassis	2	Mindy
2.6	Fabricate gas system cabling	4	Mindy
2.7	Fabricate exterior I2C cabling	4	Mindy
3	**Testing**		
3.1	D0 measurements of spherical mirrors - pre-reflective coating	2	Mindy
3.2	Acceptance tests of RMC	4	Tyler
3.3	Acceptance tests of backplane PCB	4	Tyler
3.4	D0 measurements of spherical mirrors - post-reflective coating	6	Mindy
3.5	Reflectivity testing of spherical mirrors	6	Mindy
3.6	Acceptance tests and verification of SHT35 sensor PCBs	4	Tyler
4	**Detector Assembly**		
4.1	Prepare cleanroom areas	2	Facilities
4.2	Assemble electronic panel	7	Mindy
4.3	Assemble detector shell	2	Mindy
4.4	Install hardware interlock sensors and cabling	2	Mindy
4.5	Install nitrogen supply lines	2	Mindy
4.6	Install cooling supply lines	2	Mindy
4.7	Install planar mirrors	2	Mindy
4.8	Install spherical mirrors	2	Mindy
4.9	Install electronic panel	2	Mindy
4.10	Align mirrors	2	Tyler
4.11	Assemble exit window	1	Mindy
4.12	Install exit window	1	Mindy
4.13	Install aerogel	1	Mindy
4.14	Leak check entire detector	1	Mindy
4.15	Gas seal entire detector	1	Mindy
4.16	Survey before installation	1	Survey Group
5	**Installation in Hall**		
5.1	Move detector to hall	1	Hall B
5.2	Install detector on forward carriage	1	Hall B
5.3	Move of air-cooling system to hall	2	Hall B
5.4	Connection of detector to nitrogen supply	1	Hall B
5.5	Install interlock chassis in rack	1	Mindy
5.6	Run cables from interlock chassis to detector	1	Mindy
5.7	Run cables from interlock chassis to gas system	1	Mindy
5.8	Survey after installation	1	Survey Group
6	**Documentation**		

- Weekly meeting to discuss progresses and plans
- Setup injector board test
- FPGA FE test first - October
- FE adapter-MAROC-FPGA test - November
- Complete component procurement
- Clean room -> November 12
- Aerogel, mirrors, coating, electronics, services
- Services: DAQ, interlock, slow control, cables, gas, cooling(!)
- Mechanical assembly: December – February 2022
- Complete test of RICH-II in the clean room: March-April
- Move detector to Hall – April-May 2022

January 6, 2018

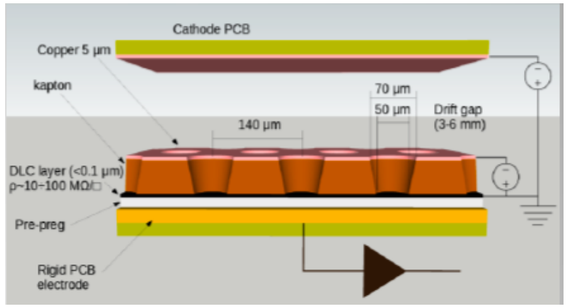


CLAS12 Hi-LUMI upgrade

Goal: double the current luminosity to operate CLAS12 at L~2 x 10^{35} cm^{-2} s^{-1} within the next 2-3 years

- CLAS12 High Luminosity operation has been included in the Lab Agenda
- Hall-B Task Forces (S.Stepanyan and S.Boyarinov)) conclusions: required a 1) new tracking detector & 2) new DAQ

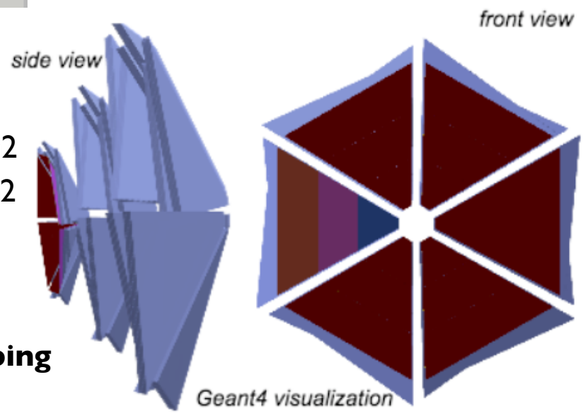
1) New CLAS12 tracking system: µ-Rwell



The µ-RWELL features:
- Compactness
- Easy assembly
- Easy powering
- Intrinsic spark quenching

Same technology proposed for EIC

The performance
- Gas gain:10^4
- Rate capability HR version: 10 MHz/cm2
- Rate capability LR version: 100 kHz/cm2
- Spatial resolution: down to 60 µm
- Time resolution:5-6 ns

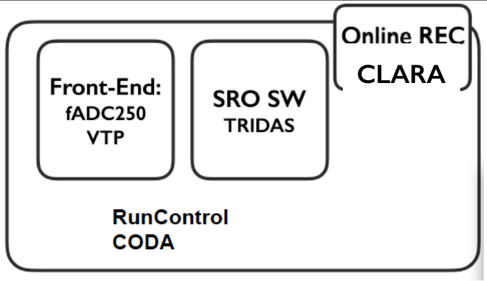


Status: CLAS12 µ-RWELL prototyping
- a prototype is being built by UVa
- full implementation in GEMC/REC software

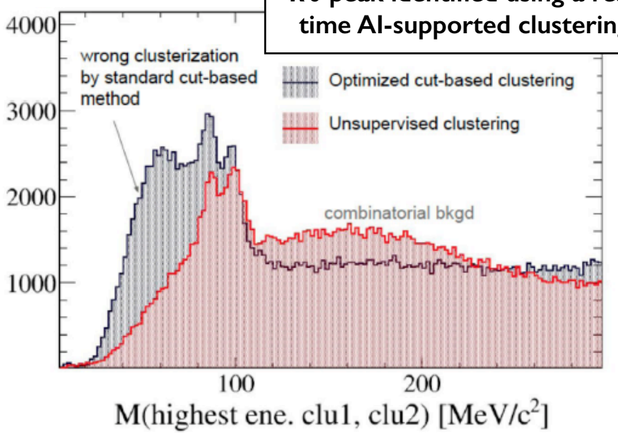
2) New CLAS12 Streaming Readout (SRO) DAQ

- current 'triggered' CLAS12 DAQ limited to 50 kHz acquisition rate
- working on a full streaming mode with 100kHz bandwidth
- Use of the current FE electronics (fADC250,VTP) and new backend software (TRIDAS)
- On-beam tests with CLAS12- FT are promising

Streaming RO CLAS12 FT tests: triggerless DAQ chain



CLAS12-FT SRO tests
π0 peak identified using a real-time AI-supported clustering



Options for µ-RWELL readout
- under test: SAMPA (ALICE) ,VMM3 (ATLAS) and FATIC2 LHCb)

Credit: S.Stepanyan, S.Boyarinov

CLAS12 future upgrades

Future Nuclear Physics Opportunities at Jefferson Lab

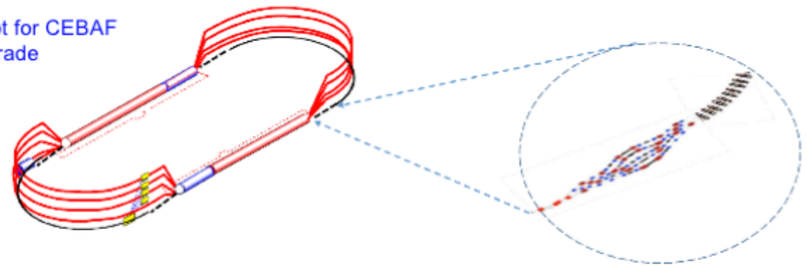
L. Harwood, G. Krafft, R. D. McKeown, W. Melnitchouk, S. Stepanyan
(Future Nuclear Physics Task Force)

September, 2020

(Thanks to C. Keppel, A. Hutton, A. Bogacz, Y. Roblin, J. P. Chen, A. Szczepaniak, A. Pilloni, and J. Qiu for input.)

- Higher luminosity/acceptance (e.g., DDVCS)
- Positron beams in CEBAF (polarized and unpolarized)
- Modest CEBAF energy upgrade (XYZ states, extend kinematic reach for nuclear femtography, ψ'(2s) photoproduction)
- Isotope production (not a major program)

FFA concept for CEBAF energy upgrade



White paper in preparation for the NSAC Long Range Plan lead by B. Mckeown + contributions from JLab and Users

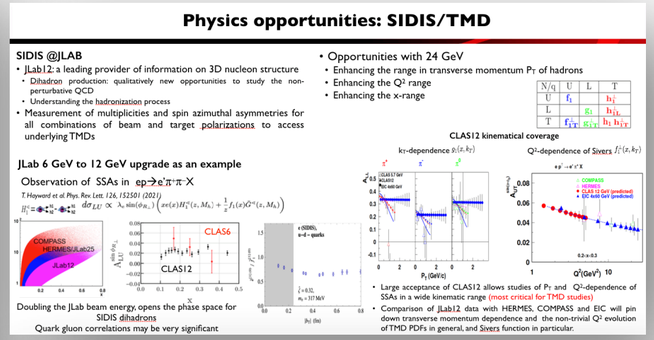
CEBAF at Hi-Lumi

- Not necessary major upgrades
- Increase in total power in the machine (from 1MW to 1.5MW) requires clearance of administrative limits and test
- Goal: run multiple high current Halls (~100uA) at max energy
- Tests planned for 2020 (pre-COVID19) will be resumed soon
- Not significant change in Hall-B (currents are limited to few uA): updating the beam-dump up to 100kW

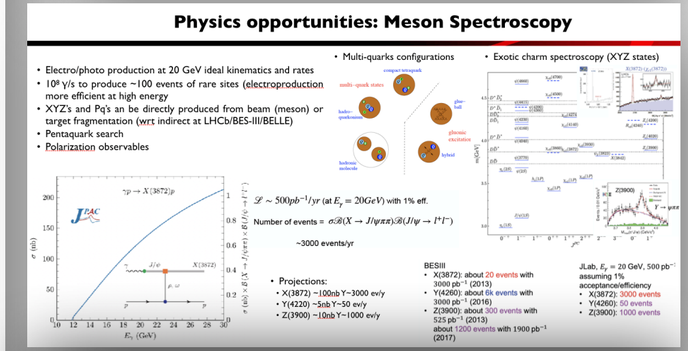
CEBAF at 23 GeV

- New recirculating arcs (increased in number), new cyomudules (up to 150 MeV to 200 MeV per pass per module)
- FFA recirculation technique (proposed for eRHIC): multiple beam energies confined and recirculated in the same beam line
- Passes 1-4 to 12 GeV and new 5-10 passes to reach 23 GeV
- Cost estimate: ~$100M
- More ambitious plan to boost CEBAF at 52 GeV also considered (very high cost ~$1.5B makes it unlikely)

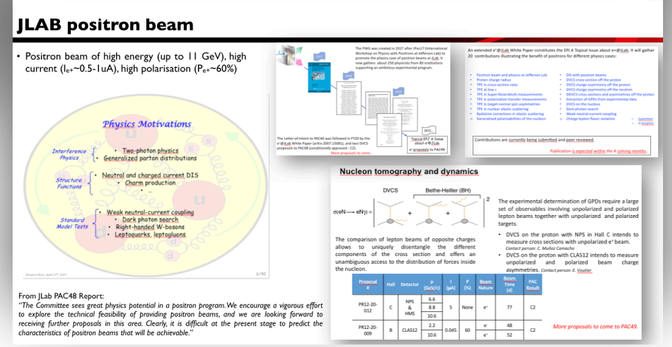
Physics opportunities: SIDIS/TMD



Physics opportunities: Meson Spectroscopy



JLAB positron beam



Great opportunity for an HPS upgrade (energy, luminosity, positrons …)

Summary

- The COVID-19 related emergency remains in place but the lab is preparing for resumption of On-site operations hopefully from the beginning of the next year we'll be back in MEDCON3
- SAD concluded with major maintenance on Hall-B systems
- HPS completed 85% of the scheduled beam-time
- CLAS12: ready to run RG-M, working on the RICH-II module to installing next year and preparing RG-C (longitudinally polarized target) to run in 2022
- CLAS12 data analysis: 2 PRL paper accepted + several in preparation
- CLAS12 data calibration/process: preparing for PASS2 and gaining understanding in detector performance
- CLAS6 Data Analysis: data mining is a rich source of physics. e4ν paper to appear in Nature journal
- On a longer range, preparing the future experiments (RG-H and other RGs) and the Hall-B HI-LUMI/HI-E operations, positron beam, ….
- Great opportunities for a rich and diversified physics program at JLab!

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… on a personal note

This is my last presentation at the HPS Collaboration meeting as Hall-B team leader

These two years have been an incredible experience: I had the onor and the privilege to lead en incredible team

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