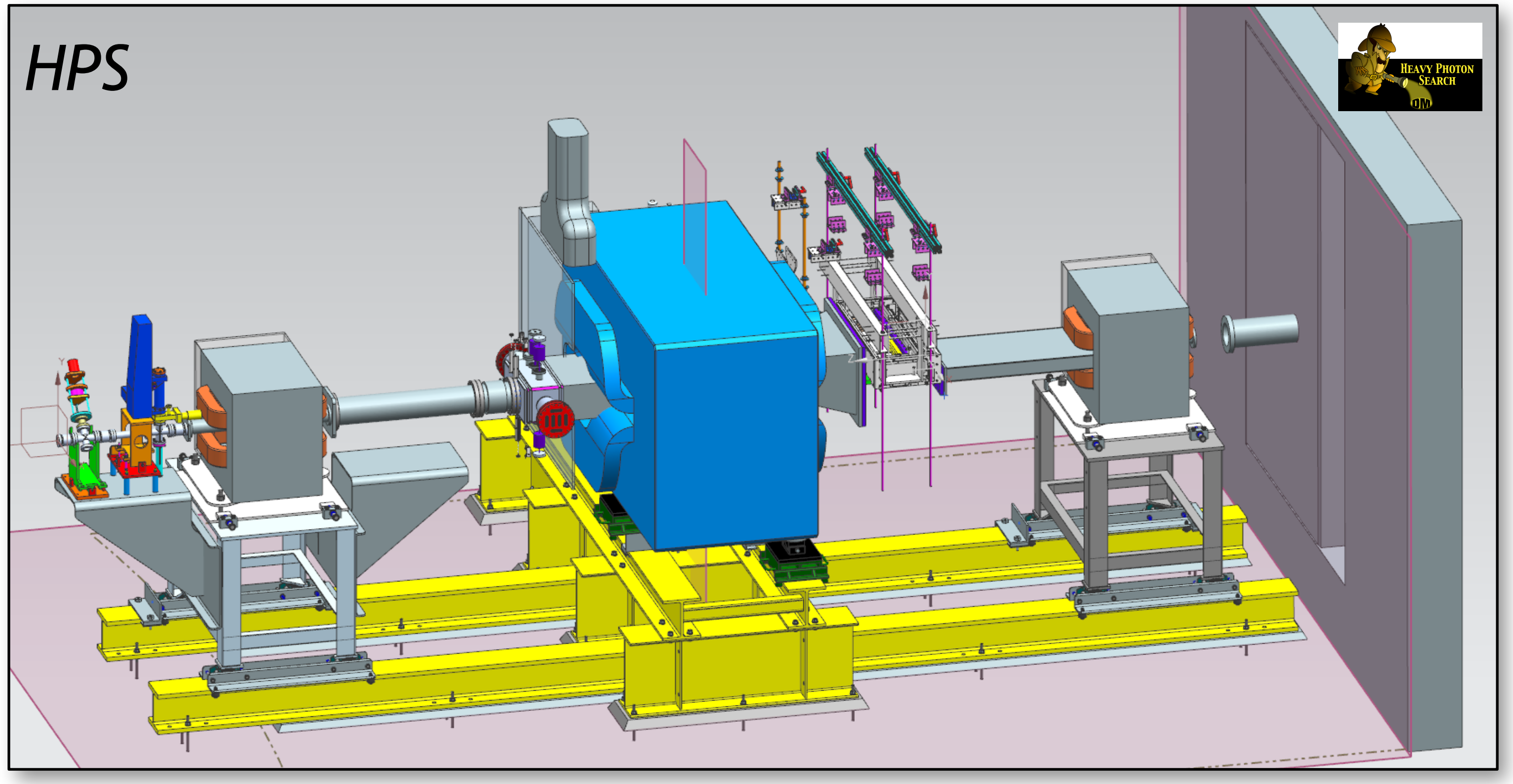
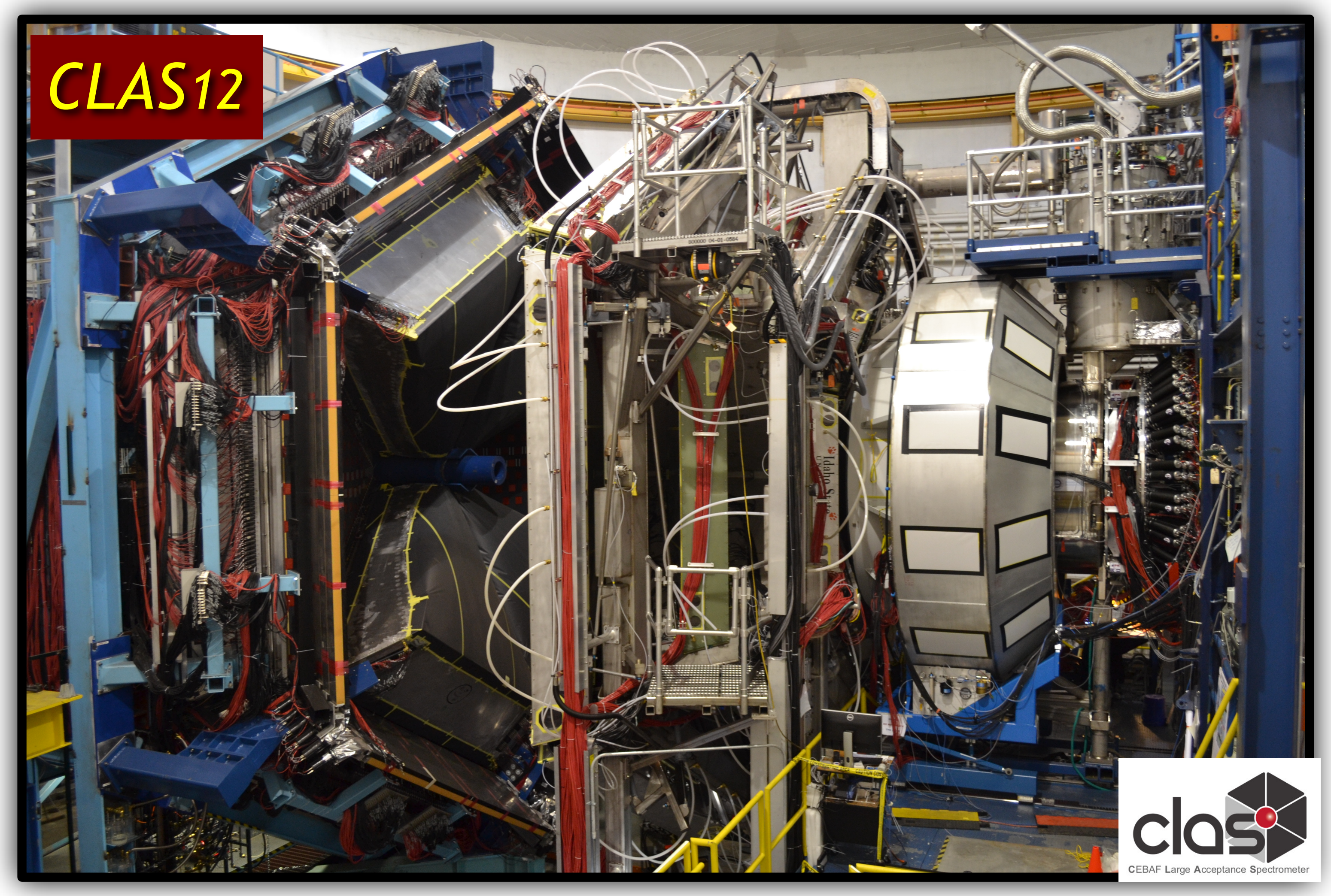
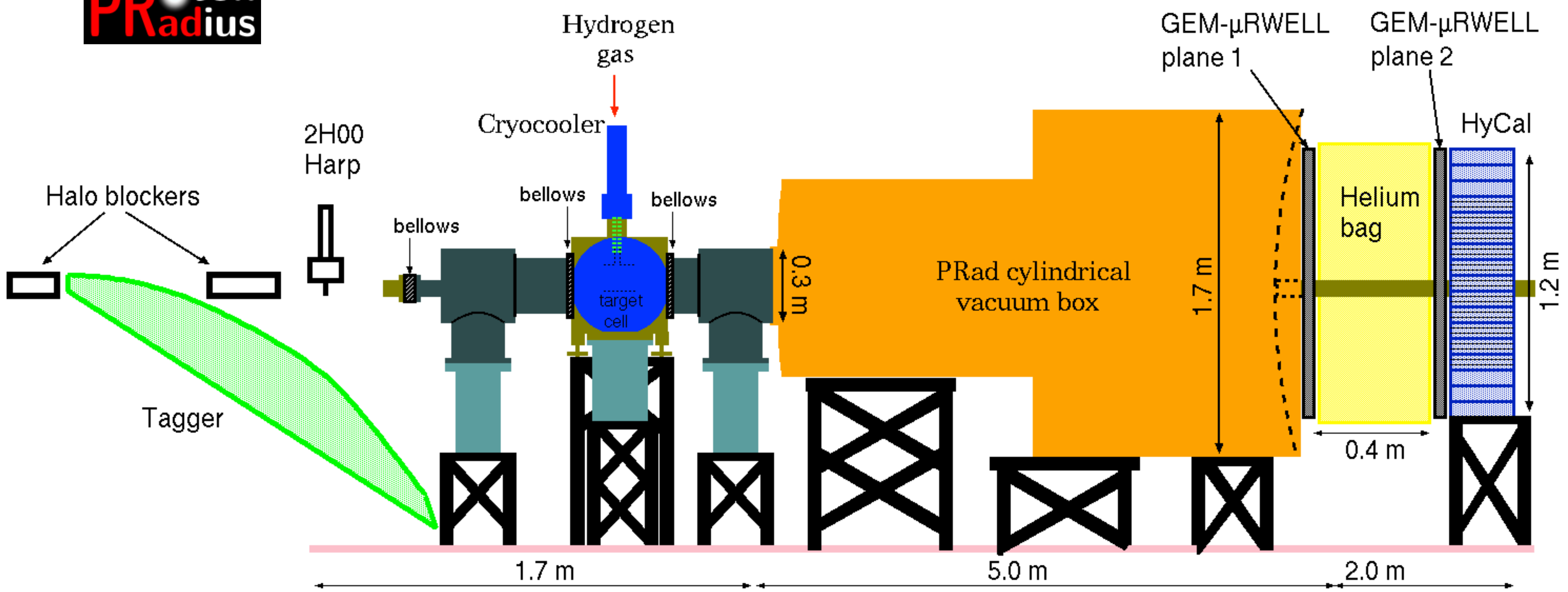




PRoton Radius



CLAS Collaboration Meeting
Jun 1-4, 2021

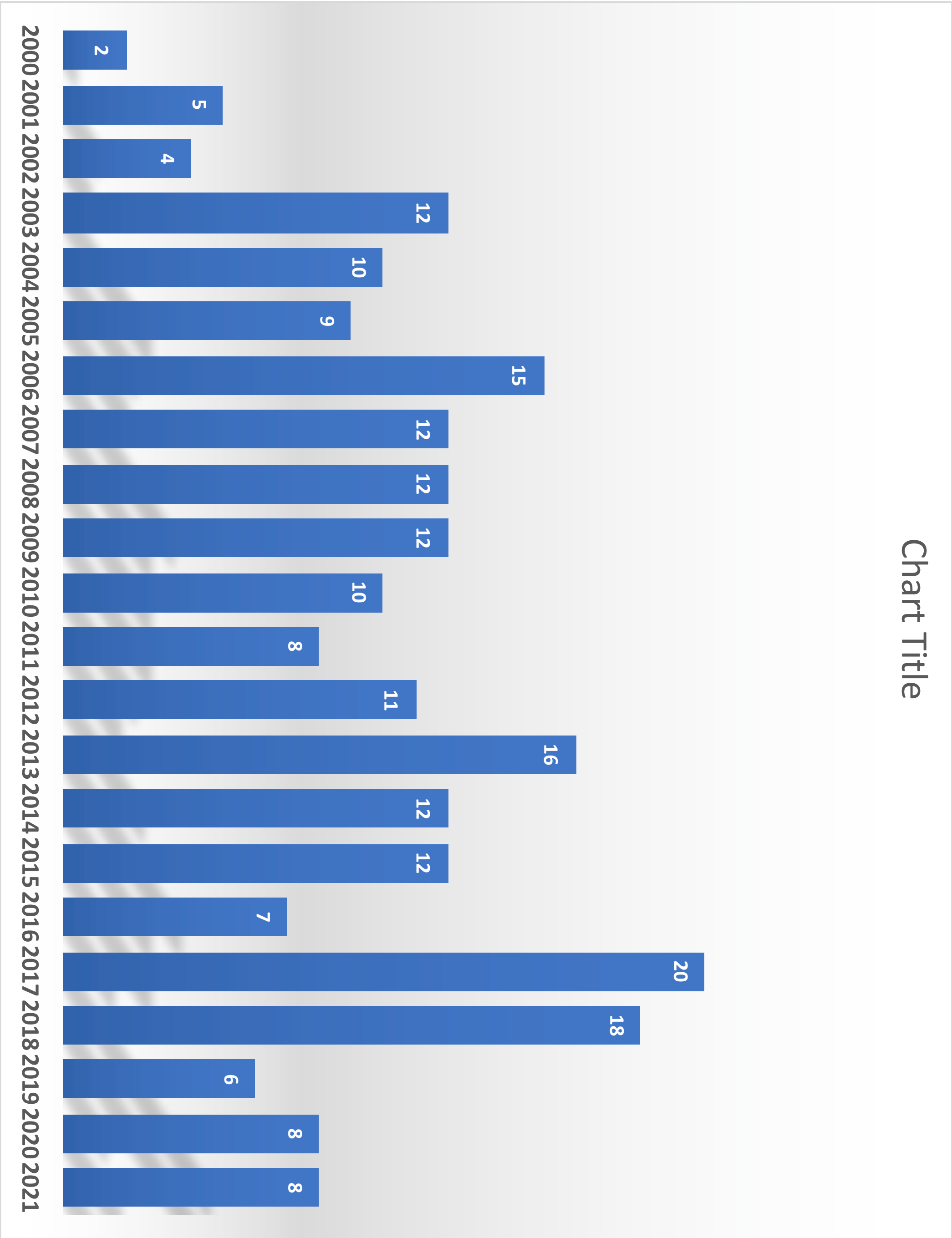
Status of Hall B

Marco Battaglieri
Jefferson Lab

Refereed Physics Publications

Hall B

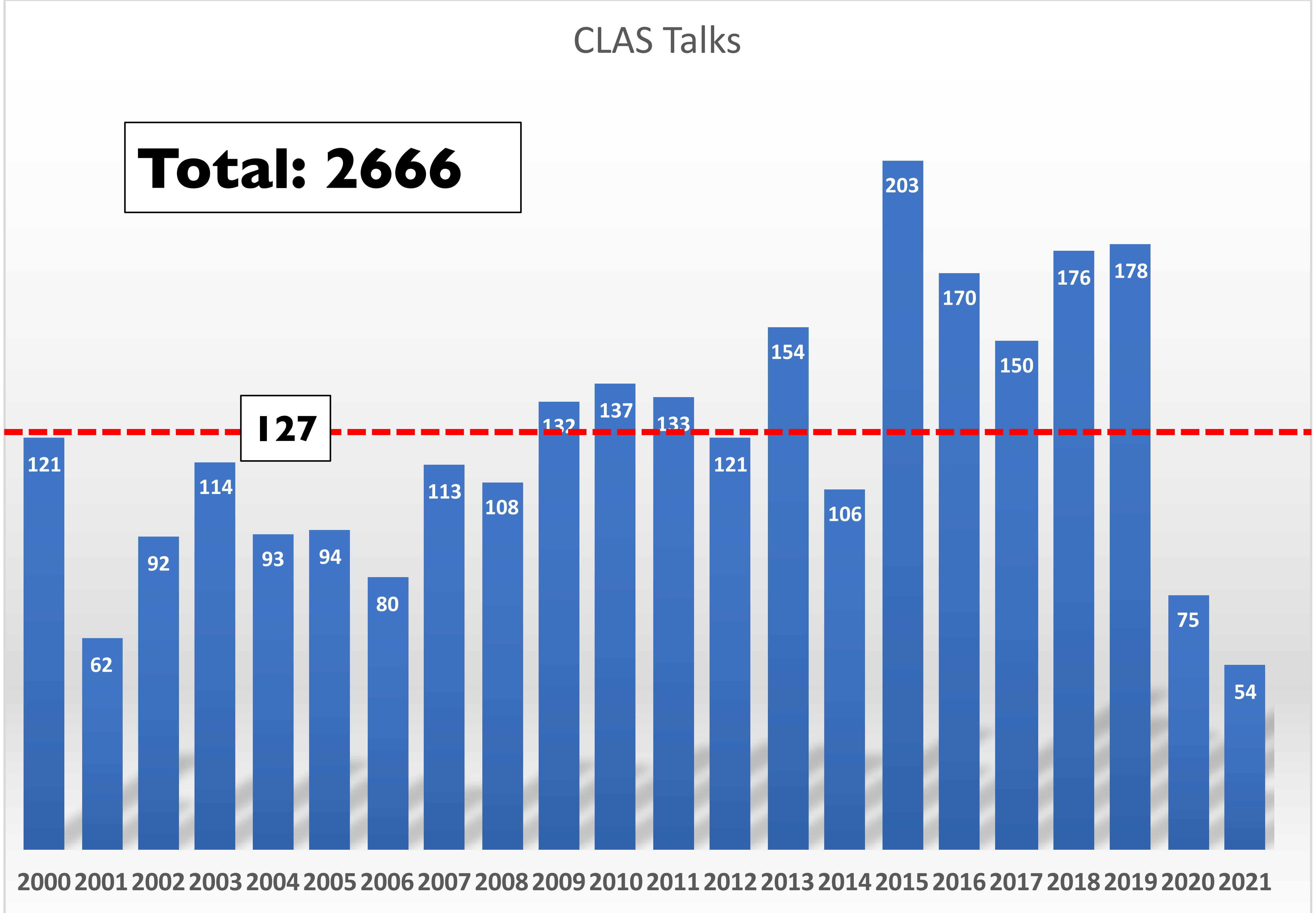
	Spectroscopy	Hard Scattering	Nuclear	ALL
2000		1	1	2
2001	2	3		5
2002	3		1	4
2003	7	4	1	12
2004	3	3	4	10
2005	7	3	2	9
2006	8	4	3	15
2007	7	2	3	12
2008	4	6	2	12
2009	8	7	4	12
2010	4	2	4	10
2011	3	1	4	8
2012	6	3	2	11
2013	8	6	2	16
2014	5	6	1	12
2015	4	5	3	12
2016	7			7
2017	12	7	1	20
2018	10	6	2	18
2019	1	2	3	6
2020	5	1	2	8
2021	2	4	1	7
SUM	116	66	46	228



- CLAS paper accepted by Nature Physics
- **1 CLAS12 paper accepted by PRL (+1 under review)**

updated 06/01/2021

Conference Presentations

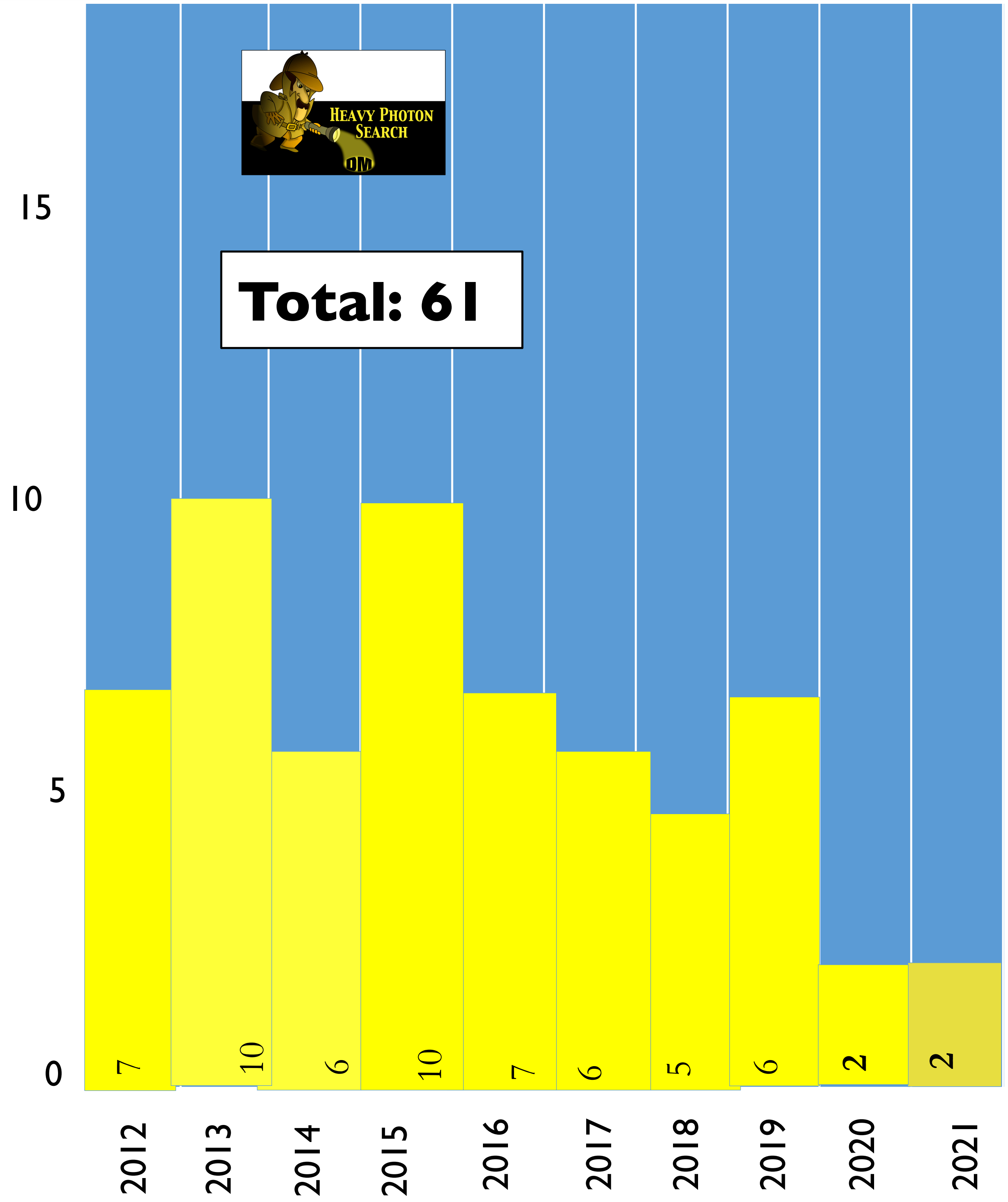


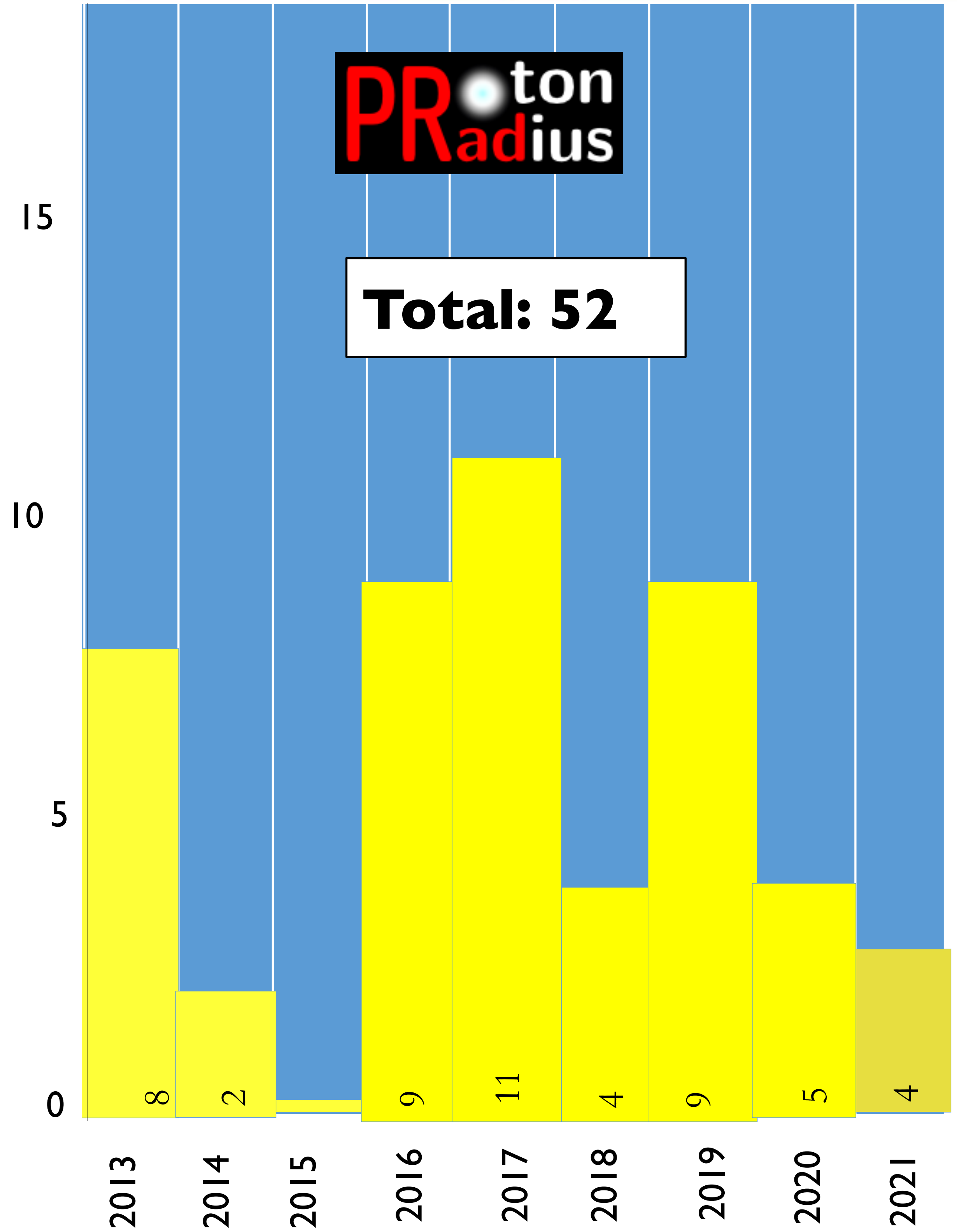
Source: CSC

updated June 1 2021

Conference Presentations

Hall B





Source: HPS & PRAD wiki

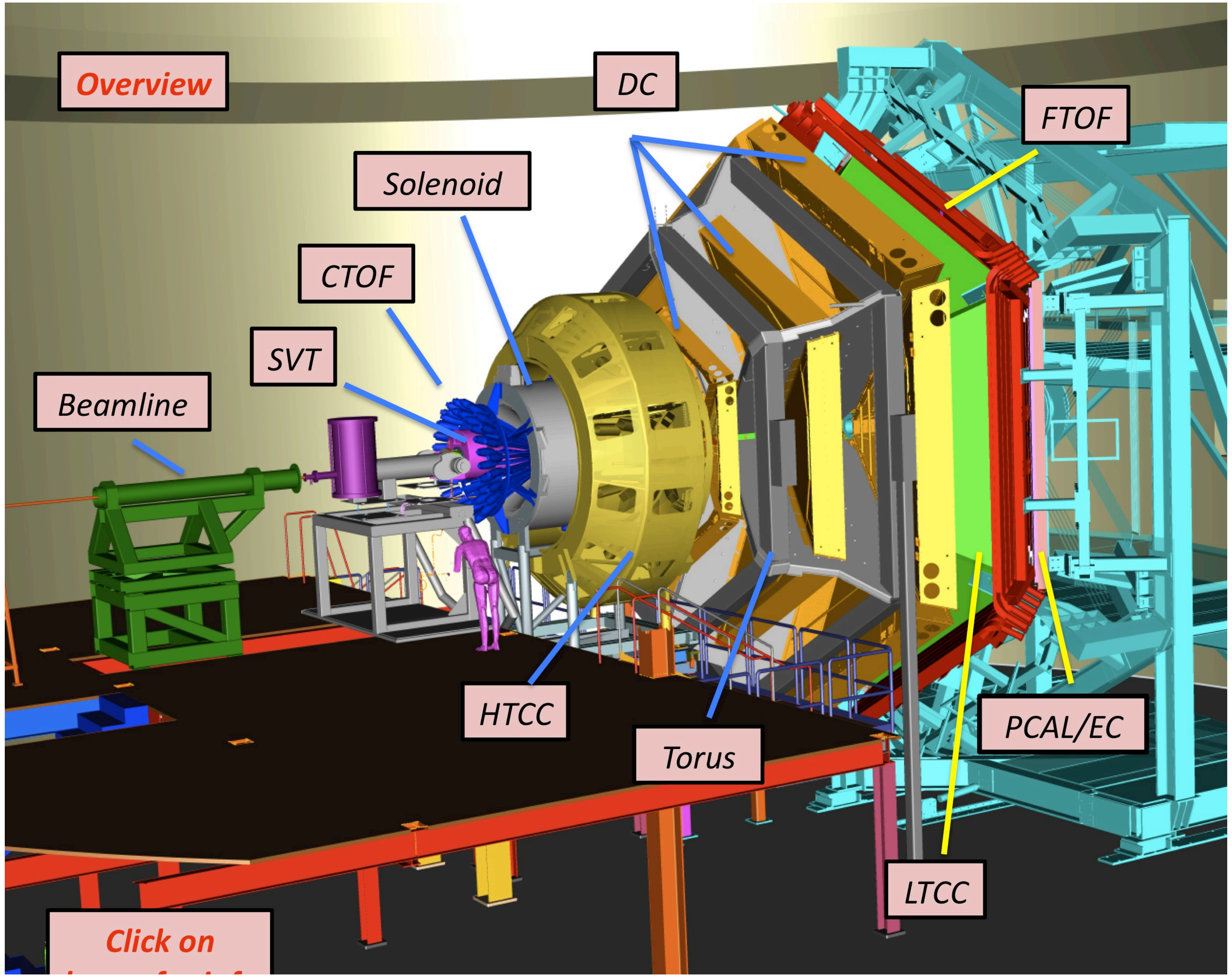
updated June 1 2021

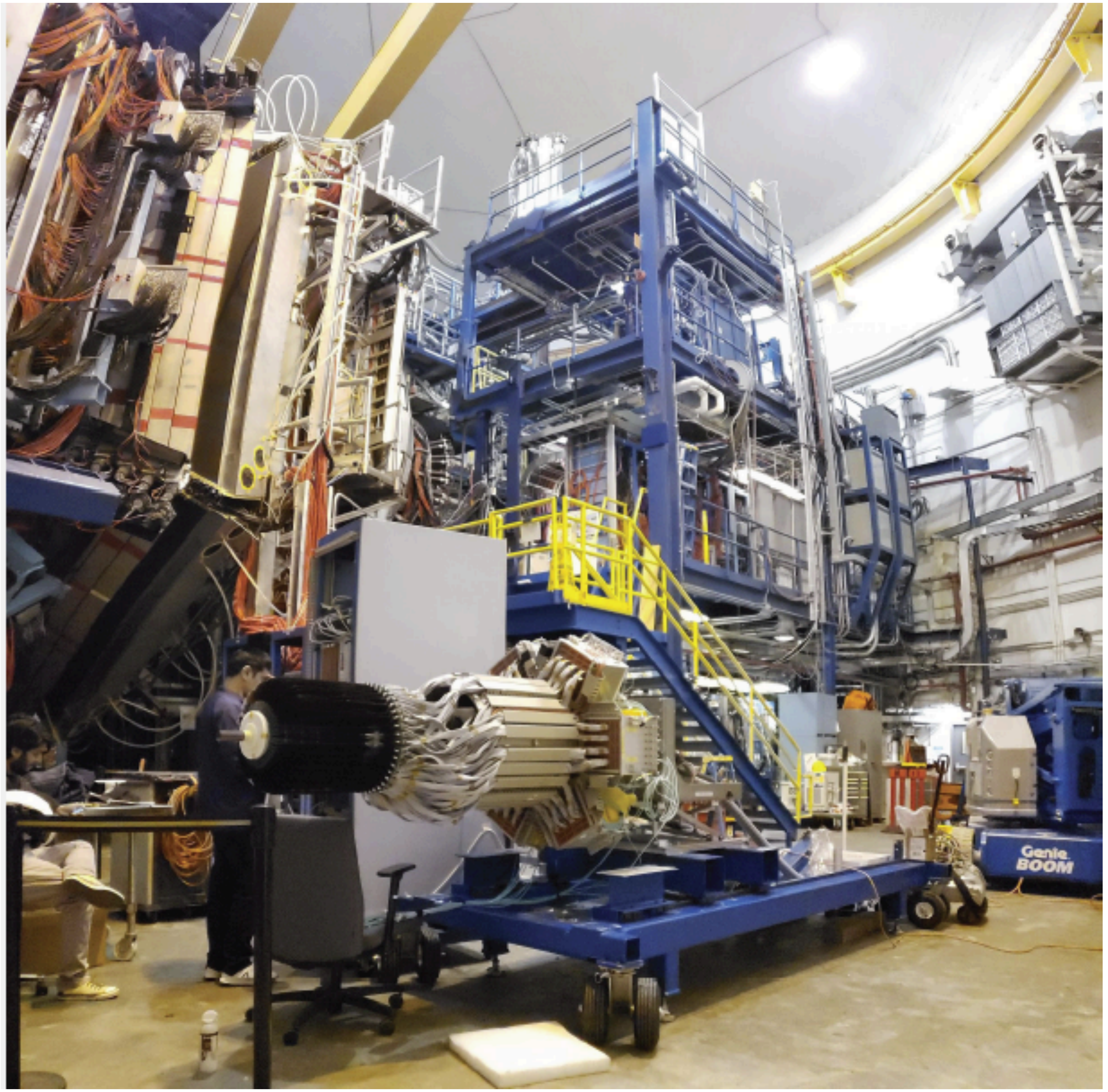
Hall B highlights

- **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)
  - 4 papers in **Nature** (+1 Nature Phys.), 1 paper in **Science**
  - >2,660 conference talks (~1,680 invited)

- **Specialized Hall B experiments**
  - PRAD experiment – results published in **Nature**
  - PRIMEX - results published in **Science**
  - Heavy Photon Search


Overview
DC
FTOF
Solenoid
CTOF
SVT
Beamline
HTCC
Torus
PCAL/EC
LTCC
Click on


Genie
BOOM

Data processing

Run Group	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
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	-	calibration in progress
	Sum20	60%	~1 week

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

CLAS12 efficiency TF

Hall-B Task Forces 2020

[edit]

Overview | Analysis Framework | Central Tracking | Data Preservation | Detector Efficiency | Forward Tracking | Novel Tracking | Polarized Targets | Particle ID | Software | Streaming GEMC | Background Merging | e- Radiation

Click here to edit this task force and here to go back to main page.

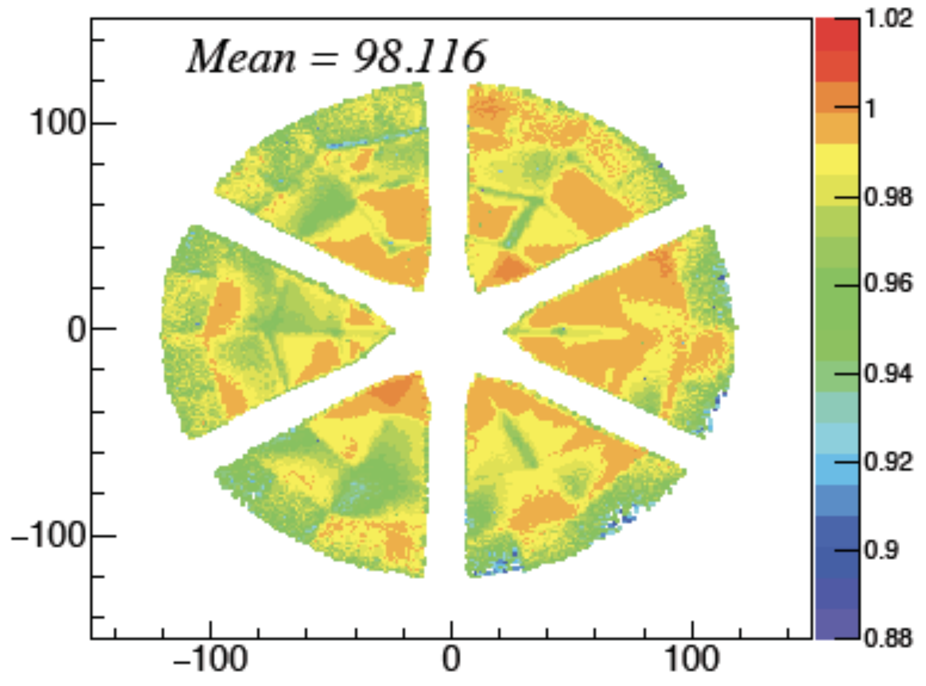
Goal

Determine the CLAS12 CD and FD efficiency considering each sub-detector and propose the proper way to make it available for the physics analyses I-

- Dedicated person/team for each subsystem
- Regular meetings of the Efficiency Task Force and a dedicated wiki page
- Significant progress on most of the subsystems

- Absolute cross sections require good understanding of CLAS12 acceptance
- From simulation/data comparison extract corrections
- Efficiency is time-dependent (detector performance, GEMC, reconstruction software)
- GEMC and REC sw tuning in progress (thresholds, status tables to account for malfunctioning elements)

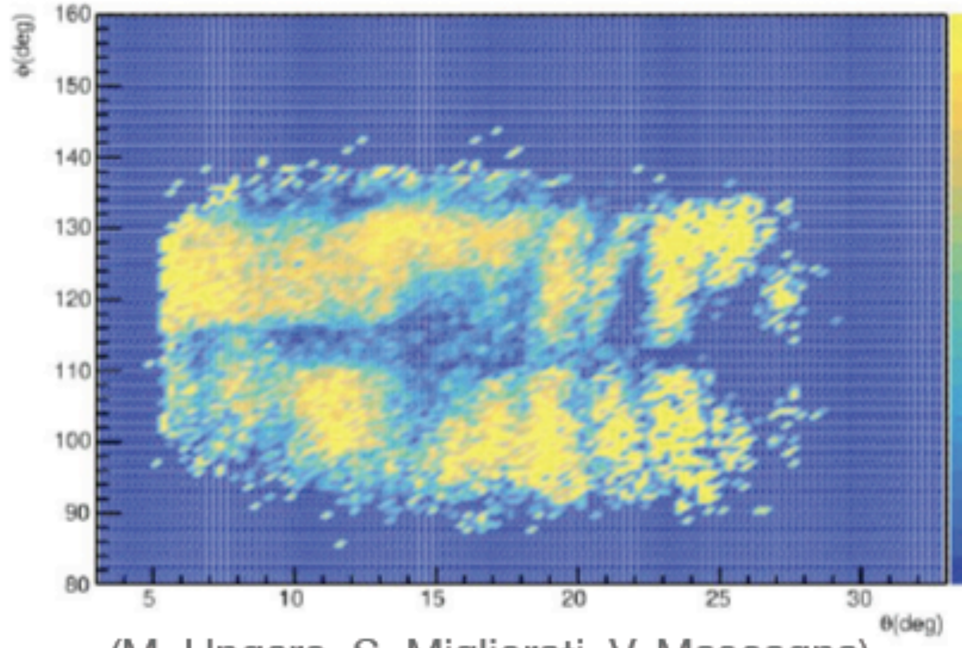
HTCC



Credit: N.Markov

LTCC

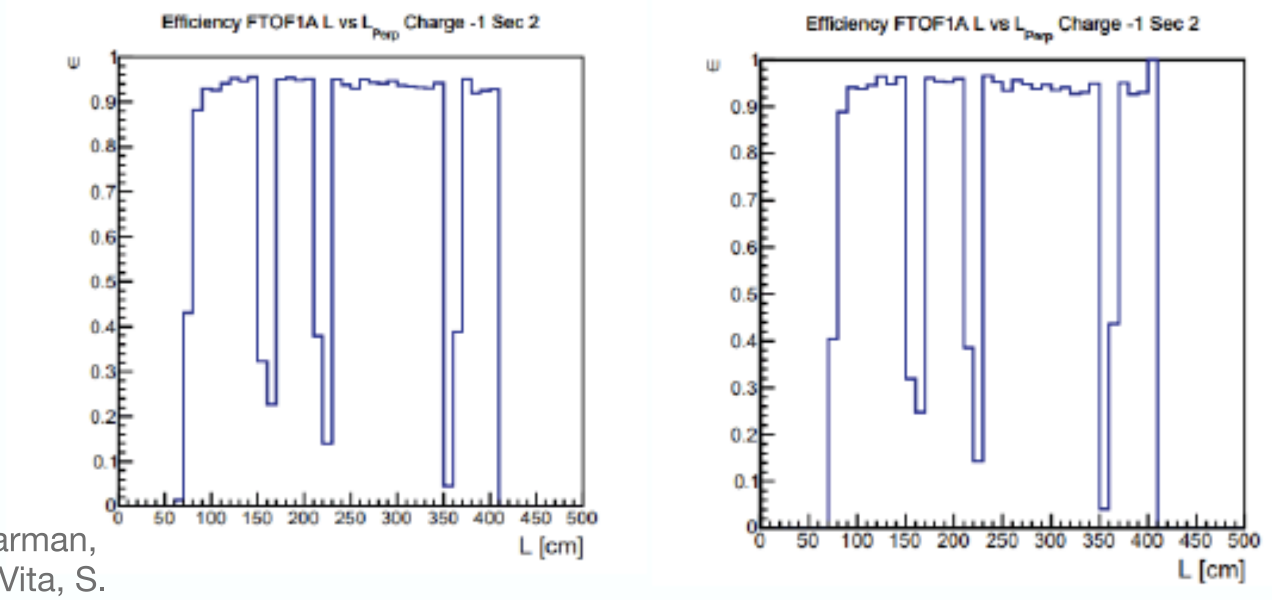
Efficiency in sector 3 [PhiV:ThetaV]



(M. Ungaro, S. Migliorati, V. Mascagna)

FTOF

Efficiency as measured by two different method
Consistent results



D. Carman, R.DeVita, S. Fegan, M. Nicol, R.Williams, N. Zachariou

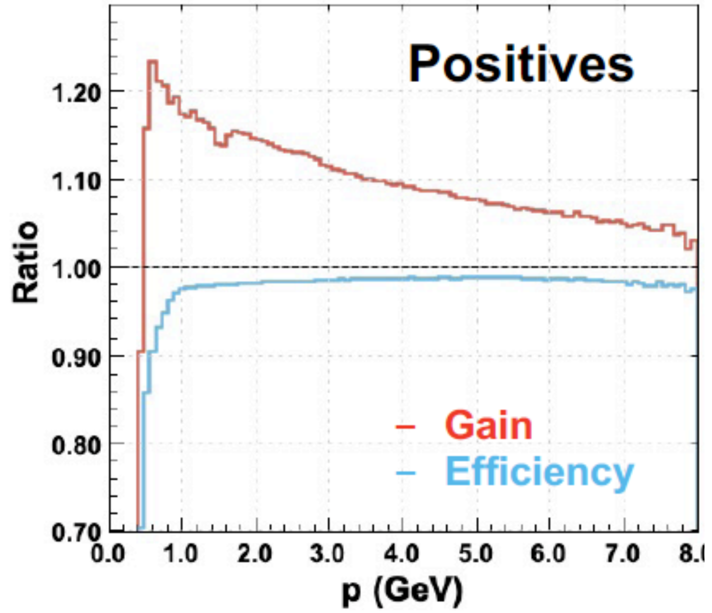
Track-based (neg)

2π Reaction (π^-)

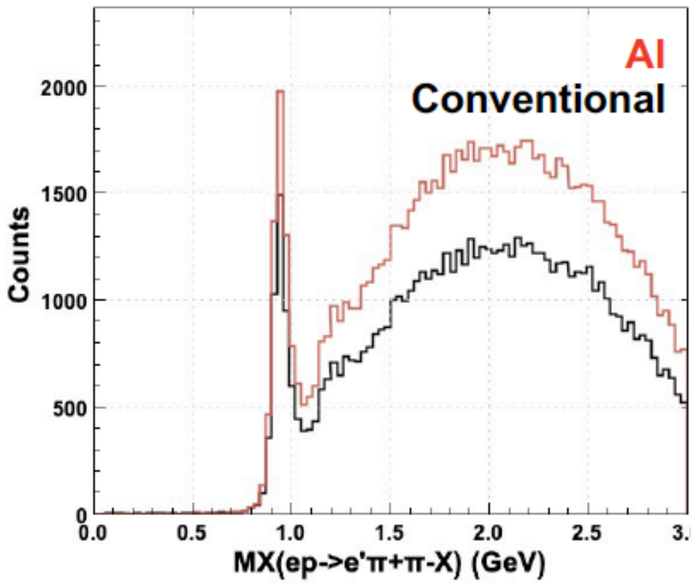
Pass2 data rec preparation

- 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

✳ **CVT reconstruction and alignment improvement**
✳ **AI-assisted tracking**
✳ **FD alignement**
✳ **Improvement in ECAL, FTOF, FT, EB + other subsystems**
✳ **Calibation: BMT, CTOF, FTCAL, HTCC, LTCC, DC, field map**

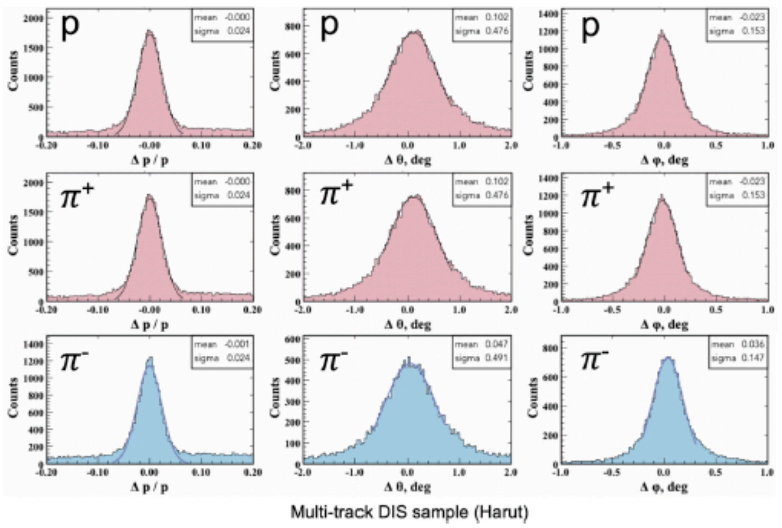


- Significant progress toward pass2 but still much work to do
- Prioriries:
  - Reconstruction: CVT, DC and ECAL
  - Alignment: CVT and RICH
- Other tasks are less critical
- Few months expected (target: end of August)
- preparations

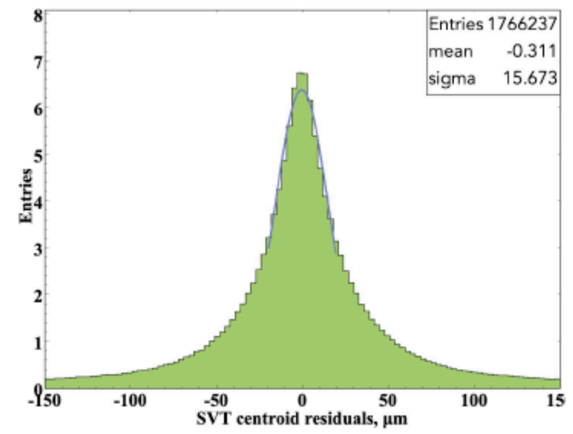


Credit: R. De Vita

SIDIS MC sample

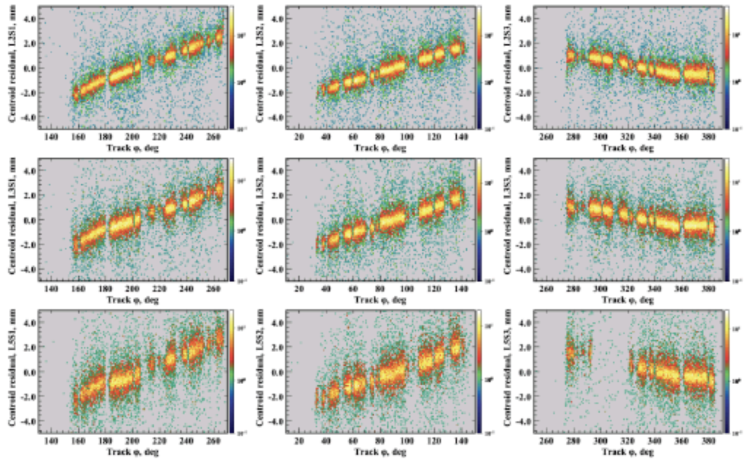


30 nA RG-K run 5700

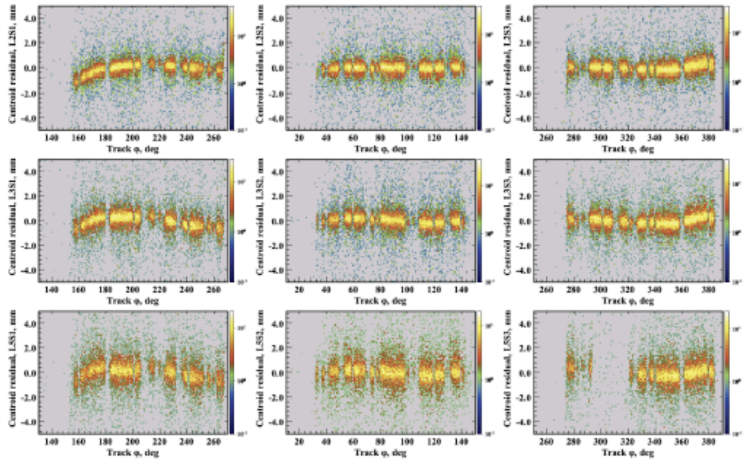


CVT reconstruction and alignement

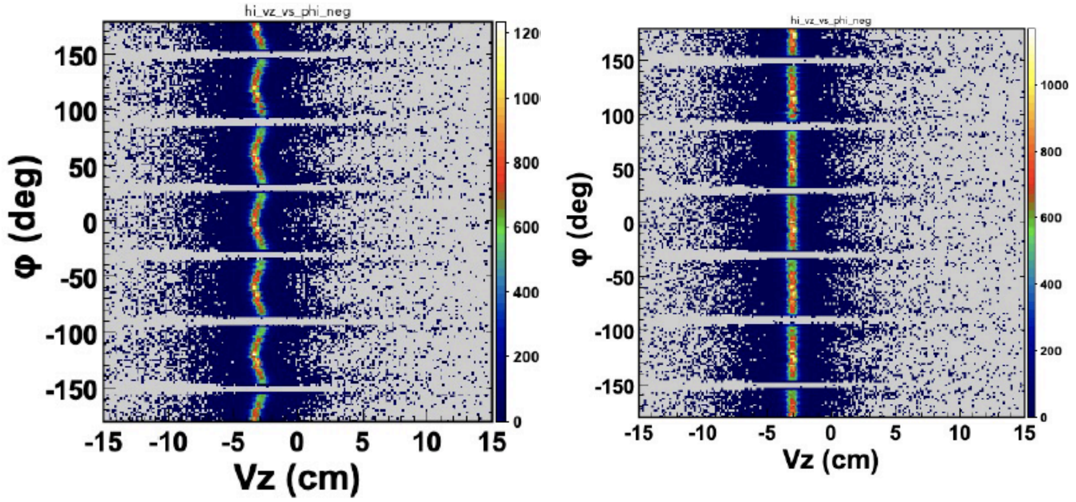
BMT-Z before pre-alignment



BMT-Z after pre-alignment



FD alignement



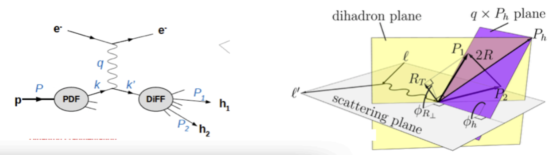
AI-Assisted tracking

CLAS12 Data analysis Hall B

CLAS12 publications

First Observation of Beam Spin Asymmetries in the Process $e\,p \rightarrow e'\,\pi^+\pi^- X$ 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) (transv polarized 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

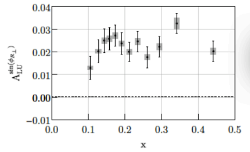


$$A_{LU} = \frac{1}{P_{beam}} \frac{N^+(\phi_h,\phi_{R_\perp}) - N^-(\phi_h,\phi_{R_\perp})}{N^+(\phi_h,\phi_{R_\perp}) + N^-(\phi_h,\phi_{R_\perp})} = A_{LU}^{\sin(\phi_h-\phi_{R_\perp})}\sin(\phi_h-\phi_{R_\perp}) + A_{LU}^{\sin(\phi_{R_\perp})}\sin(\phi_{R_\perp})$$

- Ph = P1 + P2 pions 3-mom
- RT is the component of R perpendicular to Ph
- $R_T = (z_2 P_1^\perp - z_1 P_2^\perp)/z$
- Φh = azimuthal angle of q × Ph plane
- ΦR⊥ = azimuthal angle of di-hadron plane

CLAS12 publications

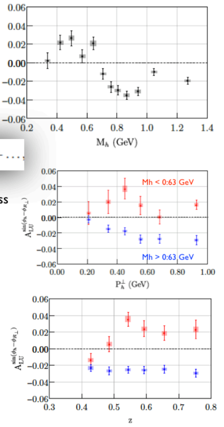
$$d\sigma_{LU} \propto W\lambda_e \sin(\phi_{R_\perp})\left(x e(x) H_1^\triangleleft(z, M_h) + \frac{1}{z} f(x)\tilde{G}^\triangleleft(z, M_h)\right) \quad (4)$$



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

$d\sigma_{LU} \propto C\lambda_e \sin(\phi_h - \phi_{R_\perp}) \mathcal{I}[f_1 G_1^\perp] + \ldots$

- Change of sign around ρ mass
- First measurement of TMD fragmentation in 2ππs



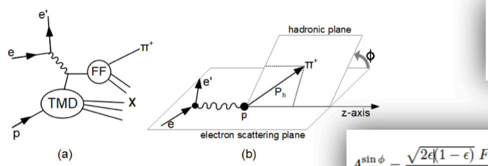
★ First measurement of BSA in di-h production
★ Sub-leading PDF e(x) different from 0
★ First helicity-deg FF $G_1^\perp$ observation

CLAS12 publications

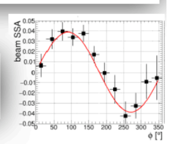
First multidimensional, high precision measurements of semi-inclusive π+ beam single spin asymmetries from the proton over a wide range of kinematics

- 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

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

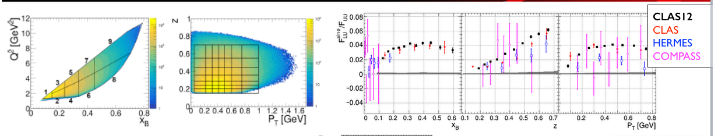


$$A_{LU}^{\sin\phi} = \frac{\sqrt{2\epsilon(1-\epsilon)}\,F_{LU}^{\sin\phi}}{F_{UU,T} + \epsilon F_{UU,L}}$$

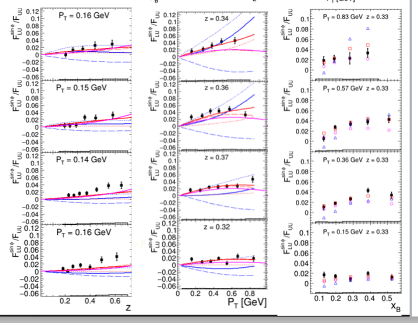


- xB= proton momentum fraction carried by the struck q
- z = γ* energy fraction carried by π
- PT = π transverse momentum
- FLU = q-g correlation (genuine tw-3) = Convolution {Collins, Boers-Mulders, tw-3 TMD pol and unpol FF}

CLAS12 publications

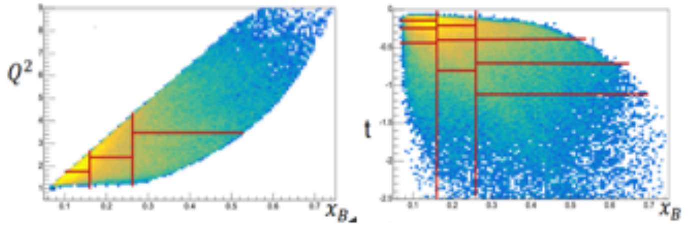


- Good kinematic coverage necessary for multi-D mapping
- Existing data are sparse and limited in kinematics
- CLAS12: Ee=10.6 GeV, Pe~86% δALU~6%
- Models:
  - 1) active q + spectator di-q (scalar)
  - 2) active q + spectator di-q (ax-vector) (best fit)
  - 3) H (parametrized) + e (chiral soliton)
-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

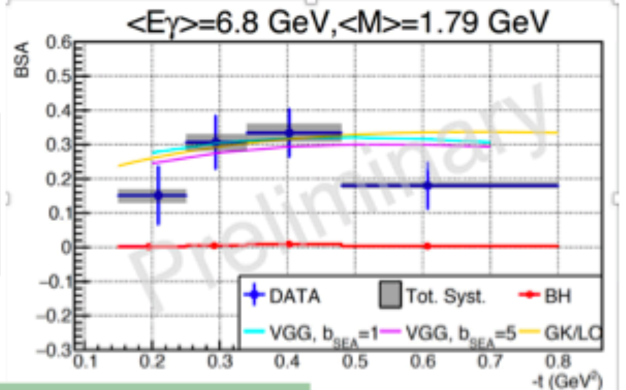


★ First multi-D measurement over a wide kinematic range
★ Extraction of Collins and TMD functions

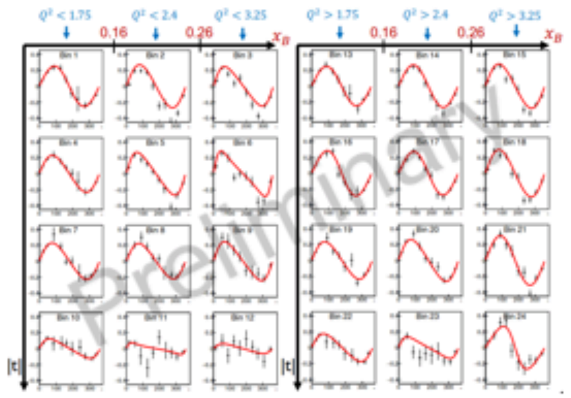
RGA - DEEP EXCLUSIVE HIGHLIGHTS

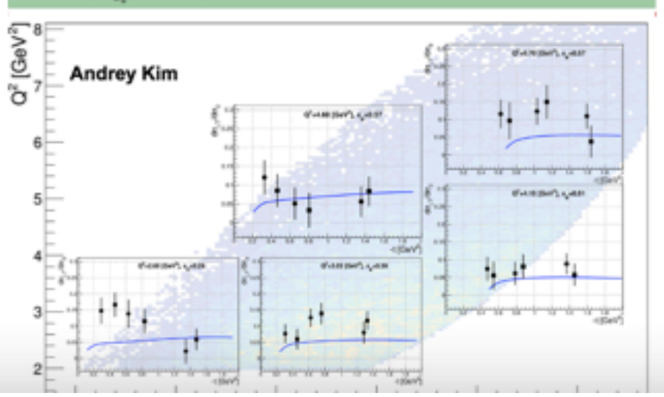


TCS – Analysis Note Approved – Preparing the paper for the Ad Hoc Committee review



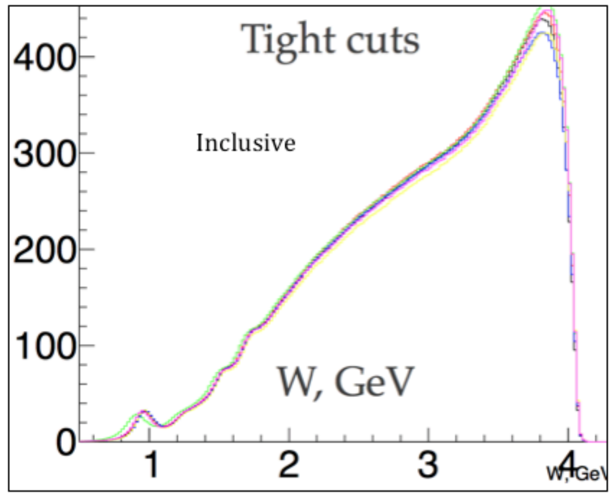
DVCS Beam Spin Asymmetry

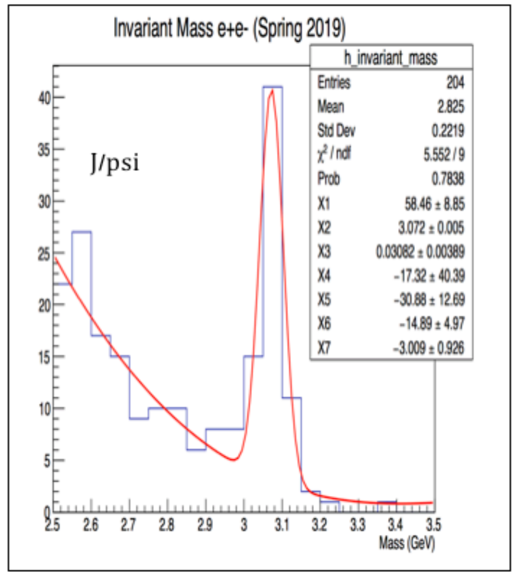




DVCS and π^0 are being finalized and analysis note being written

RGA – ANALYSIS – HIGHLIGHTS: INCLUSIVE AND J/PSI



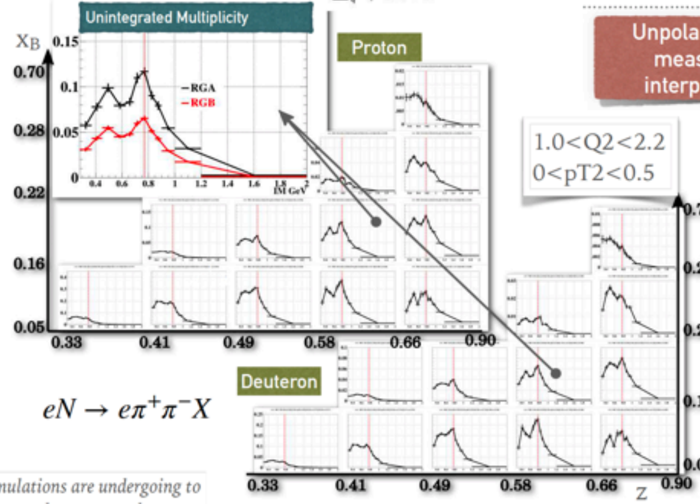


RGA- SIDIS - HIGHLIGHTS

$$M(z, Q^2, x_B, M_{ah}) \propto \frac{F_{UU}}{F_2} = \frac{\sum_q e_q^2 x_B f_1^q(x_B) D_1^q(z, M_{ah}, \cos(\theta))}{\sum_q e_q^2 x_B f_1^q(x_B)}$$

DI-HADRON MULTIPLICITIES

Unpolarized di-hadron fragmentation, first measurement ever. It is crucial for the interpretation of the BSA measurement.



$eN \rightarrow e\pi^+\pi^- X$

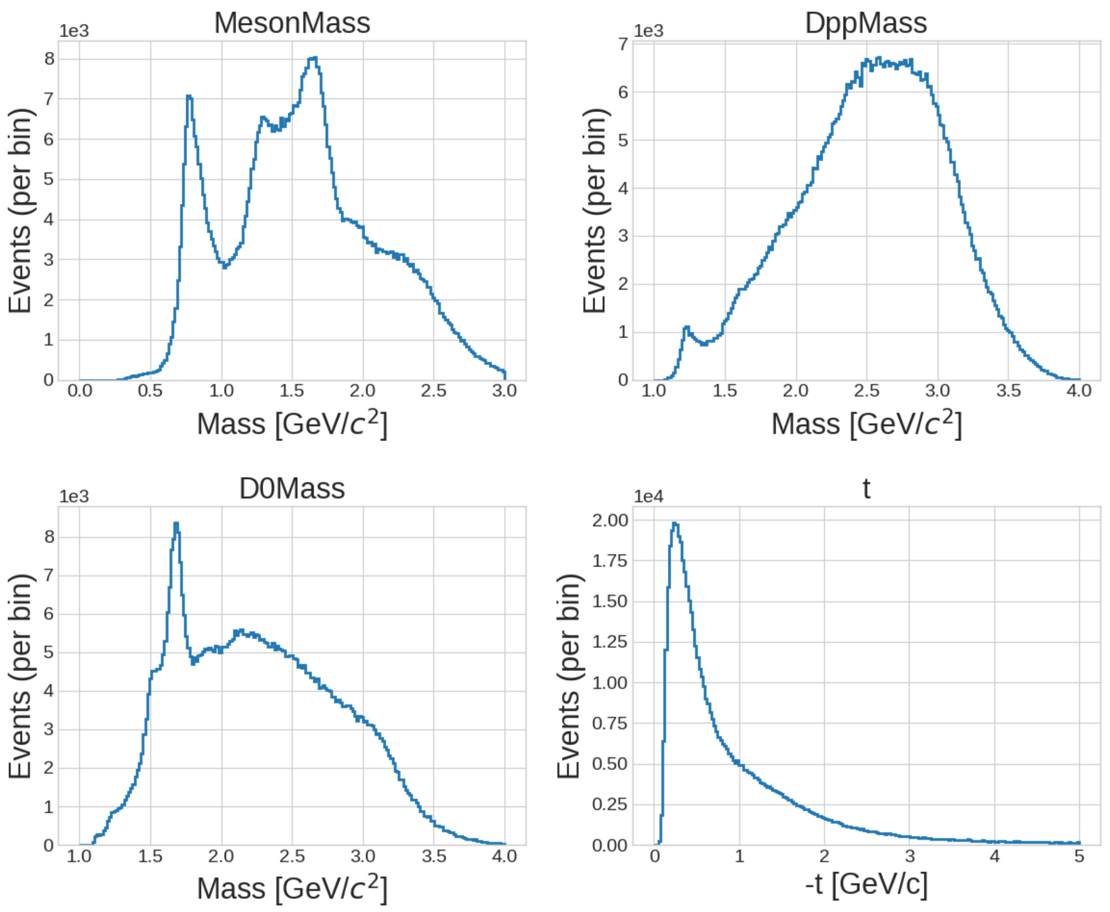
Combining proton and deuteron data we can extract the unpolarized di-hadron fragmentation function

CLAS12 PRELIMINARY

Detailed studies on new simulations are undergoing to determine fiducial volumes an phase space where we have control of the acceptance calculation

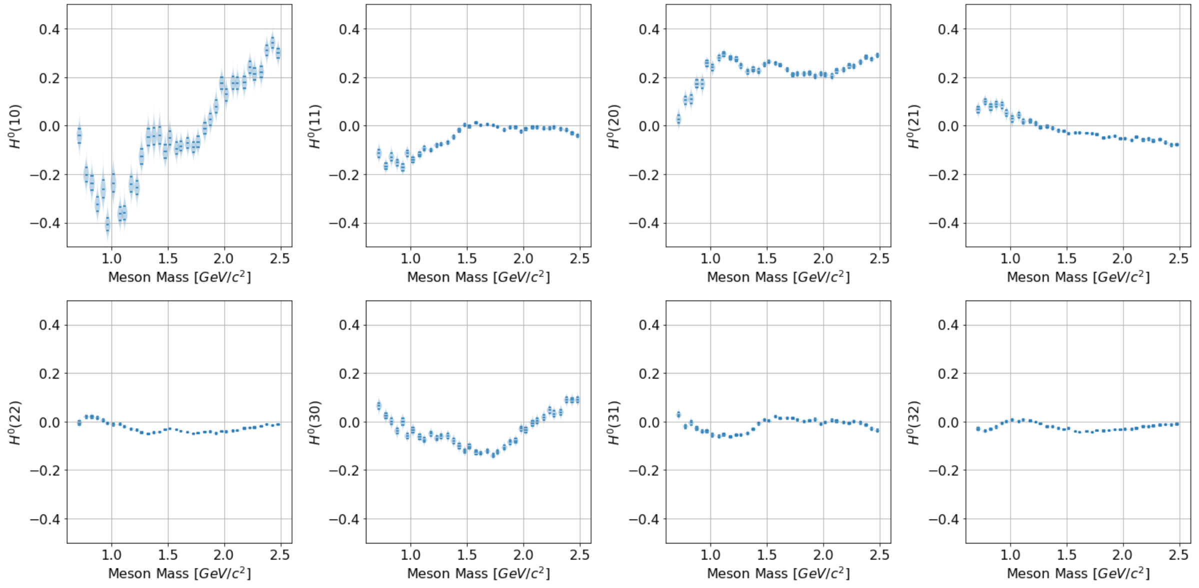
Credit: S.Diehl, T.Hayward, Latifa E.

Data analysis



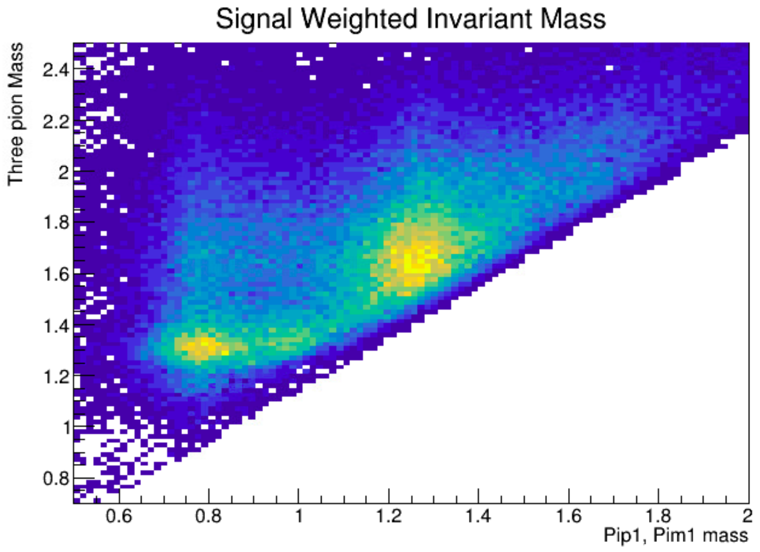
γ p→p π⁺ π⁻

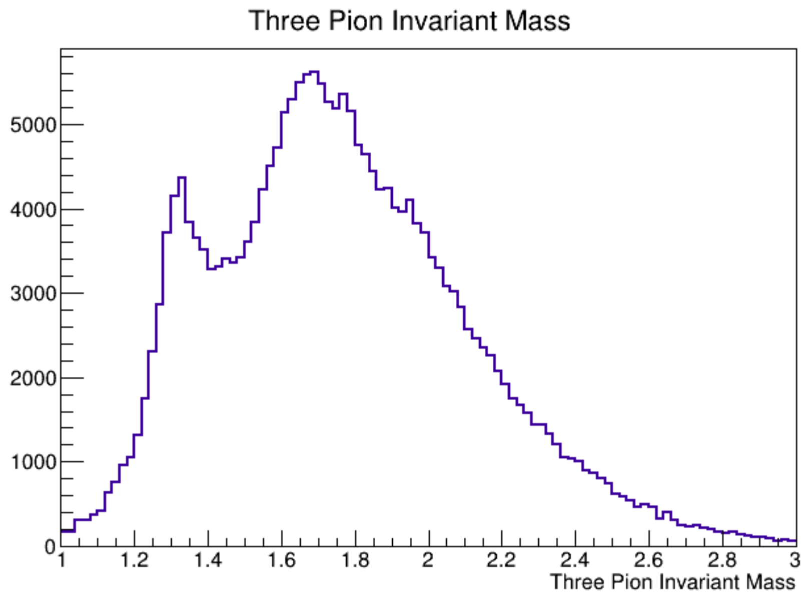
- Extraction of moments of spherical harmonics from decay angular distributions
- Next partial waves…



γ p→n π⁺ π⁺ π⁻

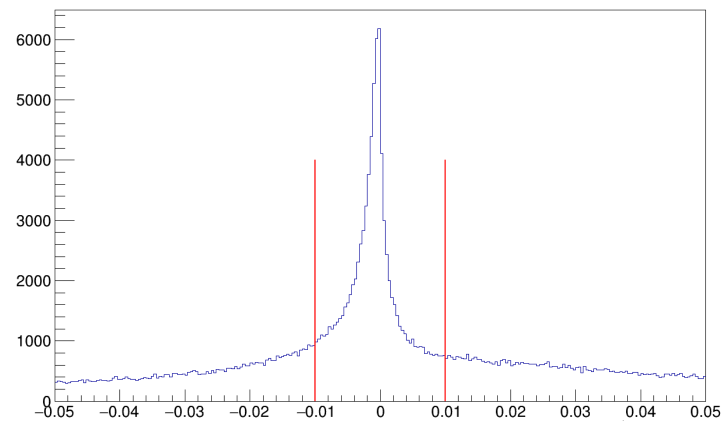
- First fits to 3 body final state via 4 decay angles have been done on small data set
- Currently finalising formalism

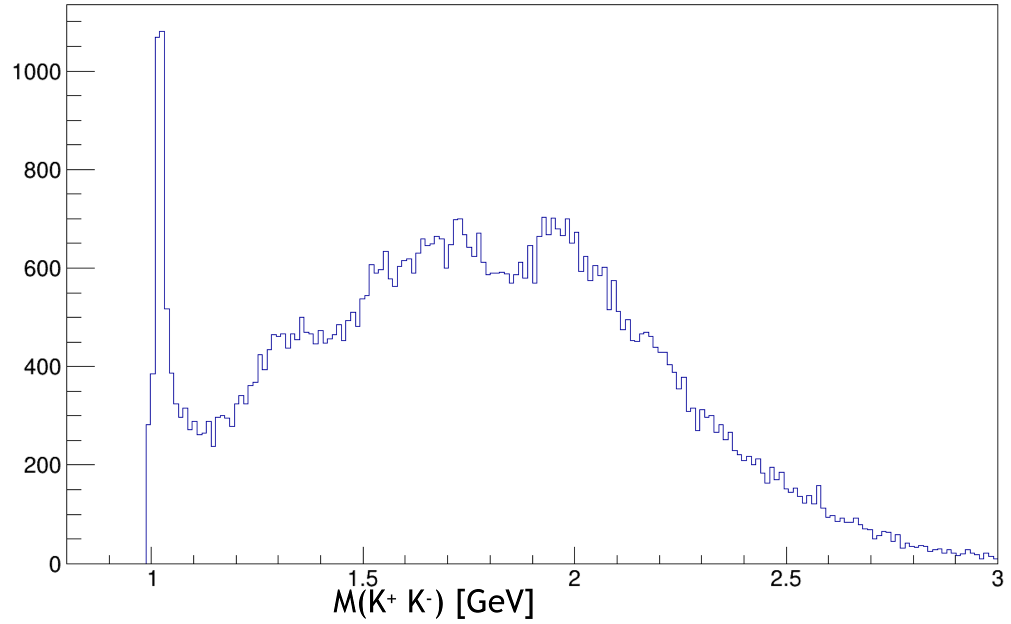




γ p→p K⁺ K⁻

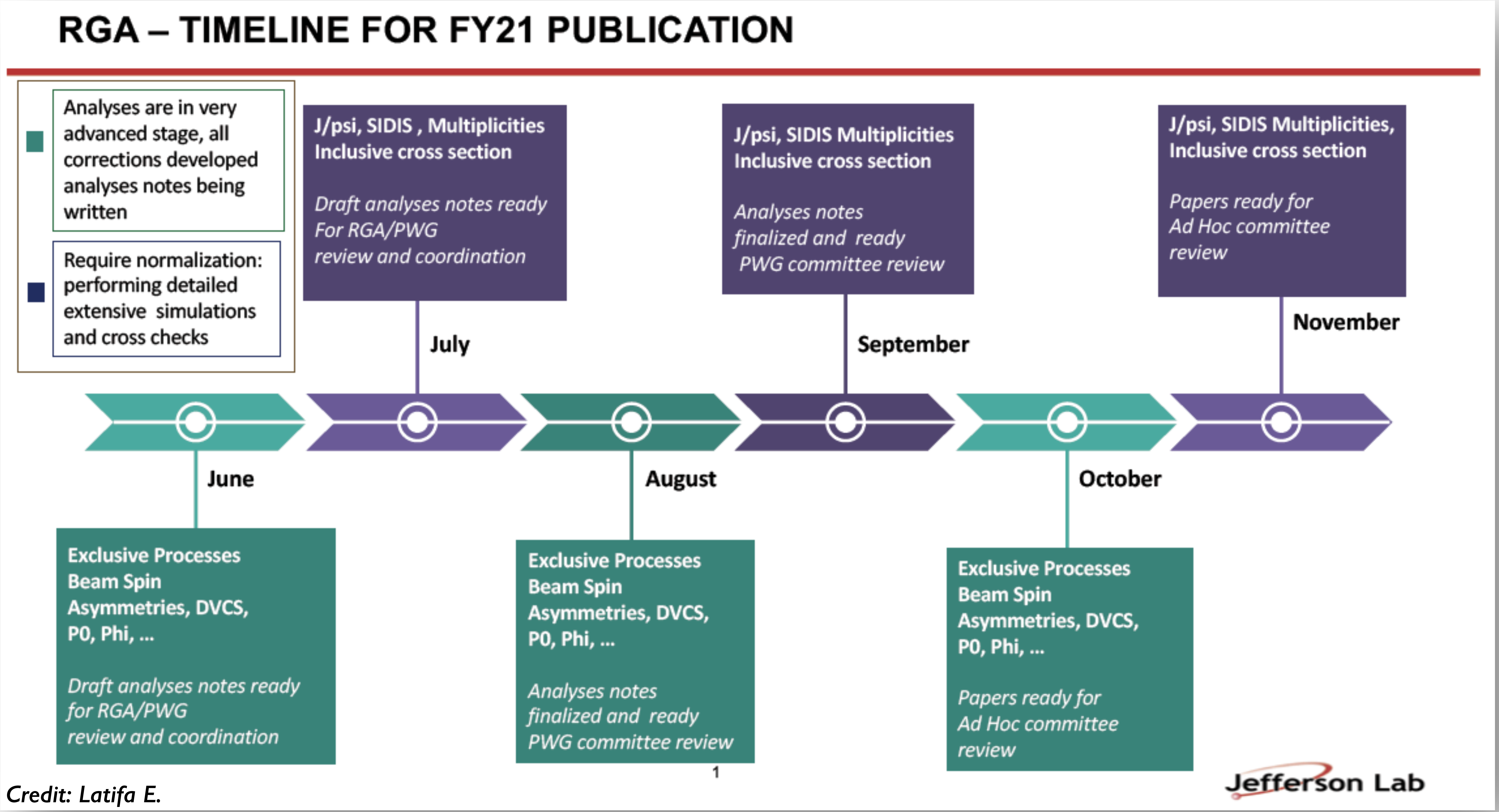
- Exclusive cut provides a clean 2K sample
- Several meson structures seen in mass spectrum





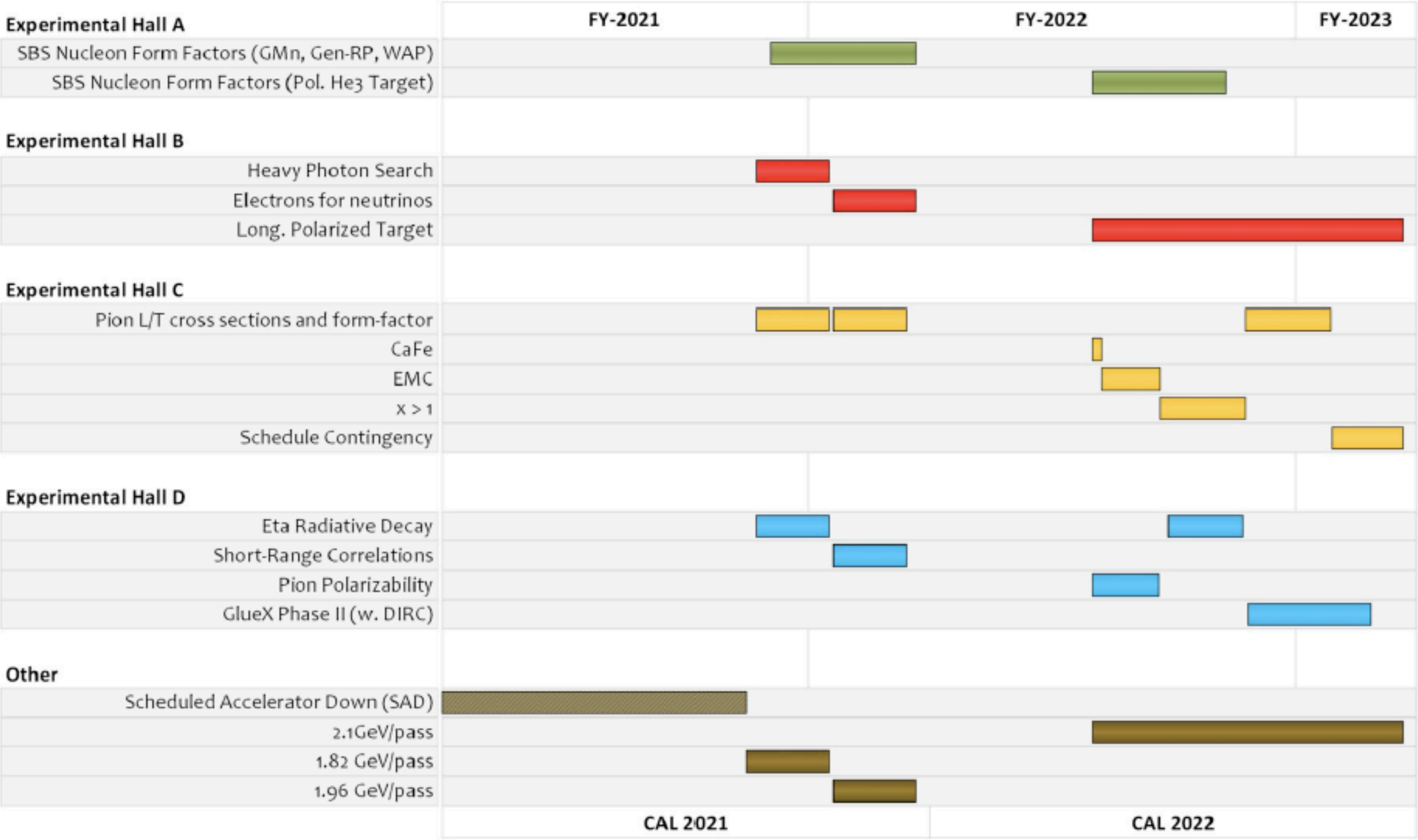
Credit: D.Glazier, A.Thornton, N. Zachariou, M.Nicol, R.Wishart

Data analysis



Credit: Latifa E.

Scheduling


FY-2021
FY-2022
FY-2023
Experimental Hall A
SBS Nucleon Form Factors (GMn, Gen-RP, WAP)
SBS Nucleon Form Factors (Pol. He3 Target)
Experimental Hall B
Heavy Photon Search
Electrons for neutrinos
Long. Polarized Target
Experimental Hall C
Pion L/T cross sections and form-factor
CaFe
EMC
x > 1
Schedule Contingency
Experimental Hall D
Eta Radiative Decay
Short-Range Correlations
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

CLAS12

Scheduling

Hall B

- Monday Aug 23 2021: resume physics with HPS at 3.7 GeV (~200 nA)

HPS: 27 PAC DAYS

13	08/20/21	Friday	1.82	Restore	INSTALL			
14	08/21/21	Saturday	1.82	Restore	INSTALL			
15	08/22/21	Sunday	1.82	Restore	INSTALL			
16	08/23/21	Monday	1.82	Physics	INSTALL		Run Group I	3.7/200/-/500
17	08/24/21	Tuesday	1.82	Physics	INSTALL		Run Group I	3.7/200/-/500
18	08/25/21	Wednesday	1.82	Physics	INSTALL		Run Group I	3.7/200/-/500
19	08/26/21	Thursday	1.82	Physics	INSTALL		Run Group I	3.7/200/-/500
20	08/27/21	Friday	1.82	Physics	INSTALL		Run Group I	3.7/200/-/500
21	08/28/21	Saturday	1.82	Physics	INSTALL		Run Group I	3.7/200/-/500
22	08/29/21	Sunday	1.82	Physics	INSTALL		Run Group I	3.7/200/-/500

- Saturday Oct 16 2021: last HPS day; RG-M installation (3 days); Wed Oct 20 start RG-M 6.0 GeV (~200 nA)

RG-M: 31/45 PAC DAYS

67	10/13/21	Wednesday	1.82	Physics	E12-09-019	5.56/40/-/500	Run Group I	3.7/200/-/500
68	10/14/21	Thursday	1.82	Physics	E12-09-019	5.56/40/-/500	Run Group I	3.7/200/-/500
69	10/15/21	Friday	1.82	Physics	E12-09-019	5.56/40/-/500	Run Group I	3.7/200/-/500
70	10/16/21	Saturday	1.82	Physics	E12-09-019	5.56/40/-/500	Run Group I	3.7/200/-/500
71	10/17/21	Sunday		Reconfigure			Install Run Group M	
72	10/18/21	Monday		Reconfigure			Install Run Group M	
73	10/19/21	Tuesday		Reconfigure			Install Run Group M	
74	10/20/21	Wednesday	1.96	Physics	E12-09-019	~~(3.74)~~ 4.0/40/-/500	Run Group M	6.0/200/-/500

- Thursday Dec 9 2021: pass change RG-M 2.1 GeV (~200 nA); Tuesday Dec 14: pass change RG-M 4.0 GeV (~200 nA)

120	12/05/21	Sunday	1.96	Physics	Sched. Contingency		Run Group M	6.0/200/-/500
121	12/06/21	Monday	1.96	Physics	Sched. Contingency		Run Group M	6.0/200/-/500
122	12/07/21	Tuesday	1.96	Physics	Sched. Contingency		Run Group M	6.0/200/-/500
123	12/08/21	Wednesday	1.96	Physics	Sched. Contingency		Run Group M	6.0/200/-/500
124	12/09/21	Thursday	1.96	Physics	Sched. Contingency		PASS CHANGE	
125	12/10/21	Friday	1.96	Physics	Sched. Contingency		Run Group M	2.1/200/-/500
126	12/11/21	Saturday	1.96	Physics	Sched. Contingency		Run Group M	2.1/200/-/500
127	12/12/21	Sunday	1.96	Physics	Sched. Contingency		Run Group M	2.1/200/-/500
128	12/13/21	Monday	1.96	Physics	Sched. Contingency		Run Group M	2.1/200/-/500
129	12/14/21	Tuesday	1.96	Physics	Sched. Contingency		PASS CHANGE	
130	12/15/21	Wednesday	1.96	Physics	Sched. Contingency		Run Group M	4.0/200/-/500
131	12/16/21	Thursday	1.96	Physics	Sched. Contingency		Run Group M	4.0/200/-/500
132	12/17/21	Friday	1.96	Physics	Sched. Contingency		Run Group M	4.0/200/-/500
133	12/18/21	Saturday	1.96	Physics	Sched. Contingency		Run Group M	4.0/200/-/500
134	12/19/21	Sunday	1.96	Physics	Sched. Contingency		Run Group M	4.0/200/-/500
135	12/20/21	Monday	1.96	Physics	Sched. Contingency		Run Group M	4.0/200/-/500
136	12/21/21	Tuesday		OFF				

- Monday Dec 20 2021: last RGM day; on Tuesday Dec 21 2021: Acc OFF

Scheduling

- Monday May 2 2022: resume physics with RG-C: FT-ON config, few days at 2.2 GeV and then 10.6 GeV

RG-C: 116/120 PAC DAYS

152	4/25/2022	Monday	2.1	Restore				
153	4/26/2022	Tuesday	2.1	Restore				
154	4/27/2022	Wednesday	2.1	Restore				
155	4/28/2022	Thursday	2.1	Restore				
156	4/29/2022	Friday	2.1	Restore				
157	4/30/2022	Saturday	2.1	Restore				
158	5/1/2022	Sunday	2.1	Restore				
159	5/2/2022	Monday	2.1	Physics	E12-09-016	4.3/30/p/500	Run Group C	2.2/200/p?/500
160	5/3/2022	Tuesday	2.1	Physics	E12-09-016	4.3/30/p/500	Run Group C	2.2/200/p?/500
161	5/4/2022	Wednesday	2.1	Physics	E12-09-016	4.3/30/p/500	Run Group C	2.2/200/p?/500
162	5/5/2022	Thursday	2.1	Physics	E12-09-016	4.3/30/p/500	Run Group C	2.2/200/p?/500
163	5/6/2022	Friday	2.1	Physics	E12-09-016	4.3/30/p/500	PASS CHANGE	
164	5/7/2022	Saturday	2.1	Physics	E12-09-016	4.3/30/p/500	Run Group C/FT_ON	10.6/200/p/250
165	5/8/2022	Sunday	2.1	Physics	E12-09-016	4.3/30/p/500	Run Group C/FT_ON	10.6/200/p/250
166	5/9/2022	Monday	2.1	Physics	E12-09-016	4.3/30/p/500	Run Group C/FT_ON	10.6/200/p/250

- Monday Jun 27 2022: last day RG-C FT-ON; config change, Tuesday July 5 start FT-OFF config 10.6 GeV

214	6/26/2022	Sunday	2.1	Physics	E12-09-016	8.8/30/p/500	Run Group C/FT_ON	10.6/200/p/250
215	6/27/2022	Monday	2.1	Physics	E12-09-016	8.8/30/p/500	Run Group C/FT_ON	10.6/200/p/250
216	6/28/2022	Tuesday	2.1	Physics	E12-09-016	8.8/30/p/500	Configuration change	
217	6/29/2022	Wednesday	2.1	Physics	E12-09-016	8.8/30/p/500	Configuration change	
218	6/30/2022	Thursday	2.1	Physics	E12-09-016	8.8/30/p/500	Configuration change	
219	7/1/2022	Friday	2.1	Physics	E12-09-016	8.8/30/p/500	Configuration change	
220	7/2/2022	Saturday	2.1	Physics	E12-09-016	8.8/30/p/500	Configuration change	
221	7/3/2022	Sunday	2.1	Physics	E12-09-016	8.8/30/p/500	Configuration change	
222	7/4/2022	Monday	2.1	Physics	E12-09-016	8.8/30/p/500	Configuration change	
223	7/5/2022	Tuesday	2.1	Physics	E12-09-016	8.8/30/p/500	Run Group C/FT_OFF	10.6/200/p/250
224	7/6/2022	Wednesday	2.1	Physics	E12-09-016	8.8/30/p/500	Run Group C/FT_OFF	10.6/200/p/250

387	12/16/2022	Friday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250
388	12/17/2022	Saturday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250
389	12/18/2022	Sunday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250
390	12/19/2022	Monday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250
391	12/20/2022	Tuesday	2.1	Physics	Install		Run Group C/FT_OFF	10.6/200/p/250
392	12/21/2022	Wednesday		OFF				
393	12/22/2022	Thursday						

- Tuesday Dec 20 2022: last day RG-C FT-OFF; on Wednesday Dec 21 2021: Acc OFF

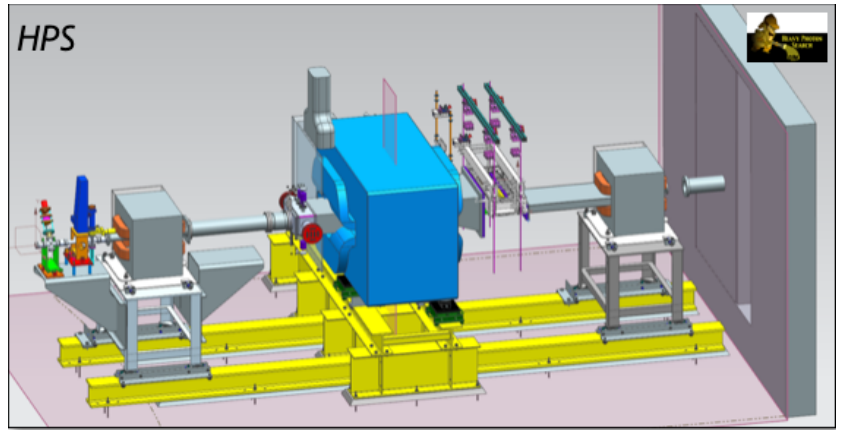
Heavy Photon Search

Hall B

★ Preparing the run: starts on August 25, beam energy 3.7 GeV. Same detector configuration as in 2019 with some upgrades and repairs

★ SVT status:

- fabrication of new FEBs and hybrids are in progress at SLAC
- new sensors for L0 and L1 have been produced at Spain and will be shipped to SLAC in a week or so
- First trip of the SVT team to JLAB planned for end of June to move services and DAQ to EEL
- Early July team will come to move SVT to the clean room for repairs. Will need 4 weeks for assembly and testing of the detector in the clean room



★ Repairs to ECal completed, cosmic calibration will follow in July when the magnet will be on the beam

★ The hodoscope is calibrated, few days of work remains for light-tightening

★ Work on DAQ and DQM upgrades started

★ Working towards shifts scheduling, looking into remotes shift taking

★ The vertexing analysis of 2016 data are approved to be unblinded, final results are expected to be released soon. Working on the paper draft.

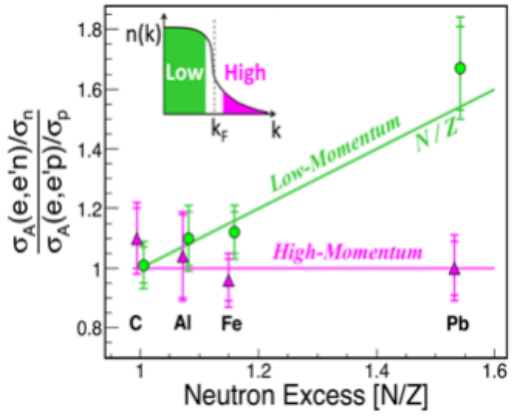
★ Most of the calibrations and alignment work for 2019 data are done. Getting ready for a "pass-0" production.

S.Stepanyan

CLAS12 — Fall 2021: RG-M — Hall B

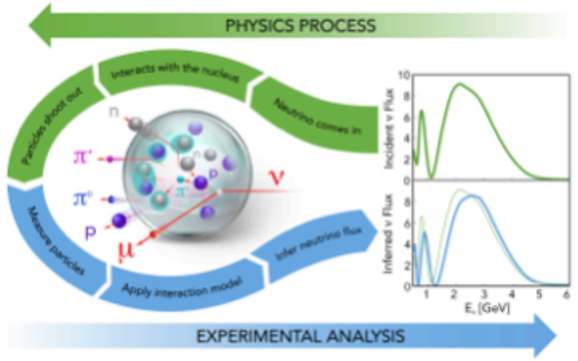
Short Range Correlations

- 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



- RG-M support Task force (PI: V.Kubarovsky)
- CLAS12 configuration completed: No FT, no LTCC, TORUS in-bending and out-bending
- FT-OFF configuration in June to be ready in October
- Target
- CVT installed
- BAND to be installed in June-July
- MC (target geometry, trigger parameters, DC roads) - started
- Target slow control – April 2021
- Detailed draft of run plan is ready (lumi scan, empty target, trigger validation, beam energy, targets, torus etc)
- The new RICH compressor installed and fully wired. Start up of the compressor in June.
- Torus field: Full inb. @ 4.4,6.6 and 0.5 @ 2.2GeV (maximized physics signals from MC simulations)
- Electron calorimeter trigger threshold investigated with MC (typical 100 MeV required)
- 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*)
- Off-line monitoring scripts being developed for looking at preliminary physics.
- Conduct of operation for Hall-B and Experiment Safety Assessment Document are ready. Radiological Safety Analysis Document is in work.

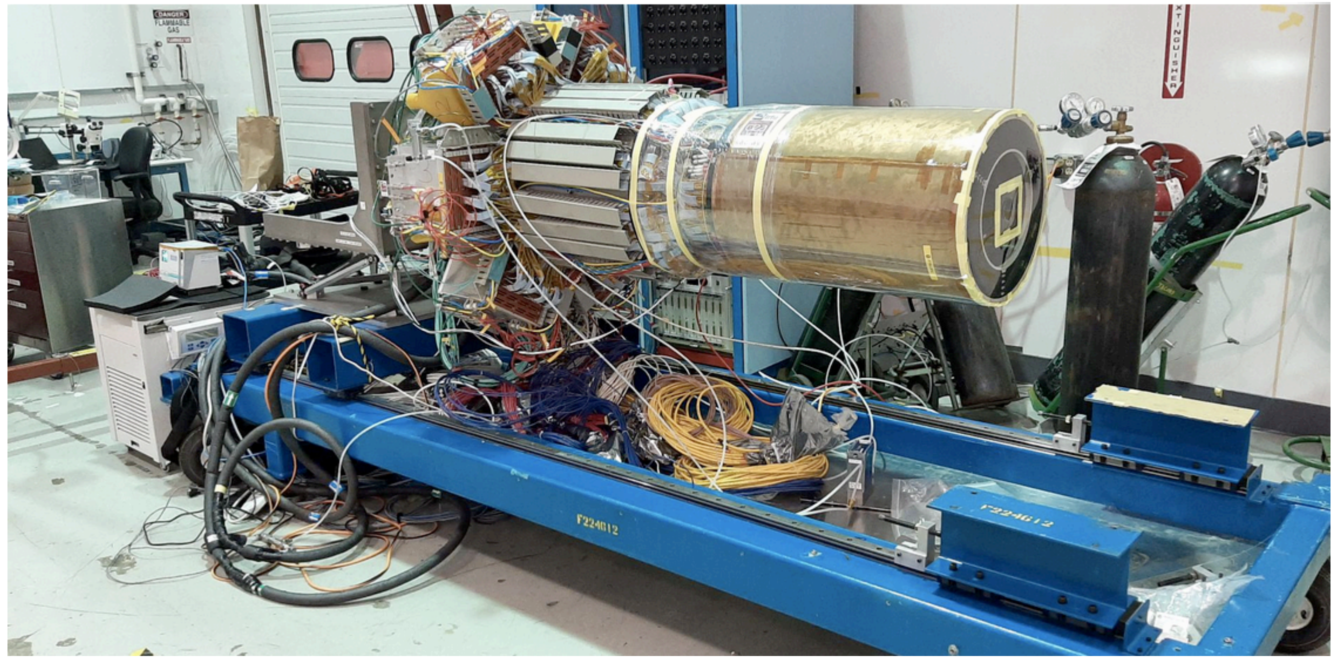
- Scheduled for 30 PAC days: (October 20 - December 20) 2021
- D, 4He, C, [O,] 40Ar, 40Ca, 48Ca, Sn

- ***Standard Hall B 5 cm long liquid cell***. 2 target cells fully assembled, tested, and ready
- ***Argon 5 mm long liquid cell.*** 2 target cells fully assembled, tested, and ready (one cell filled with liquid argon)
- ***Calcium targets.*** Dave Meekins will build Ca disks. Hall B will design and build the disk holders by June 30. Assembled and tested by the end of July.
- ***Carbon and Tin foil targets.*** Foils at Jlab. Tooling to assemble the foil holders will be done by June 4. Foil assembly will be installed in cryo target with argon cell and tested with liquid argon by the end of June

Credit: V.Kubarovsky

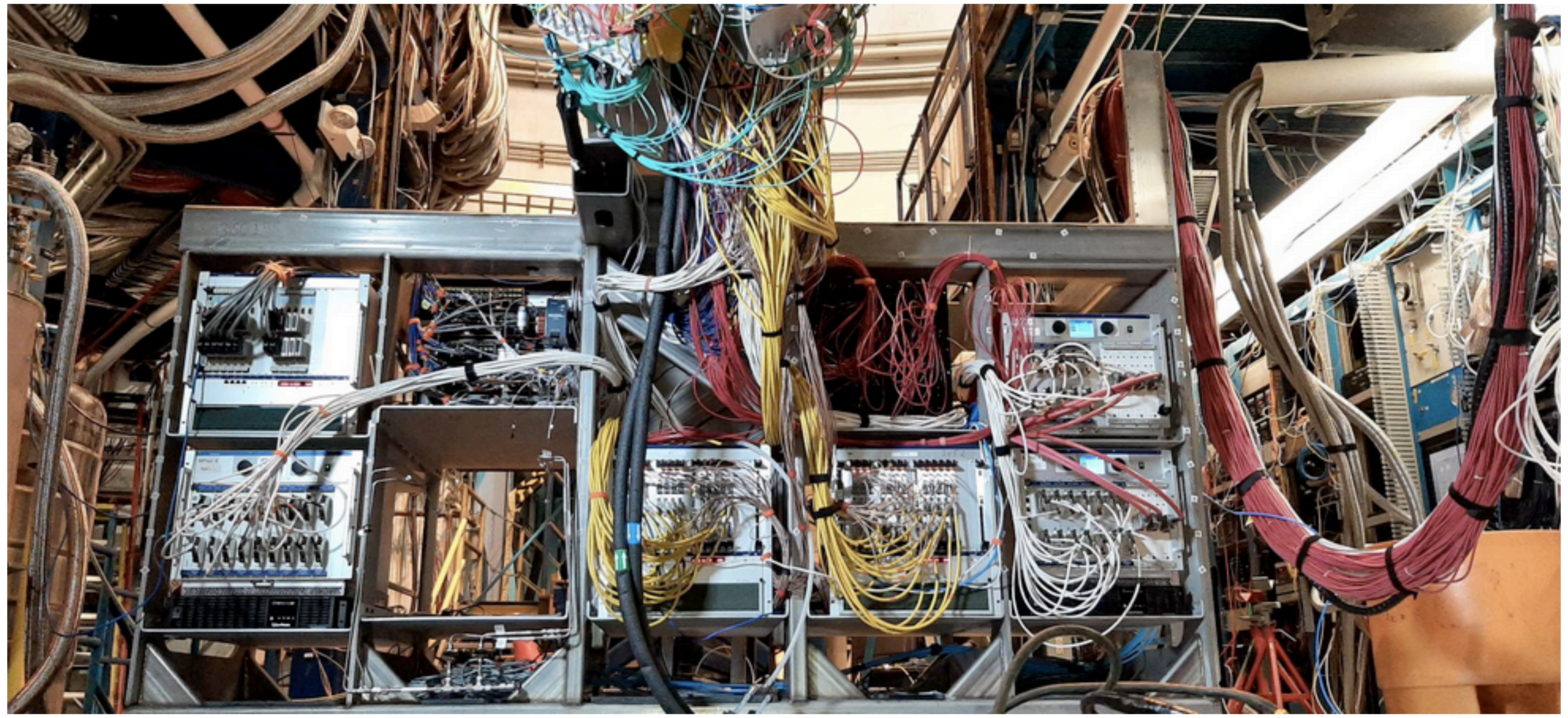
RG-M preparation

- 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!

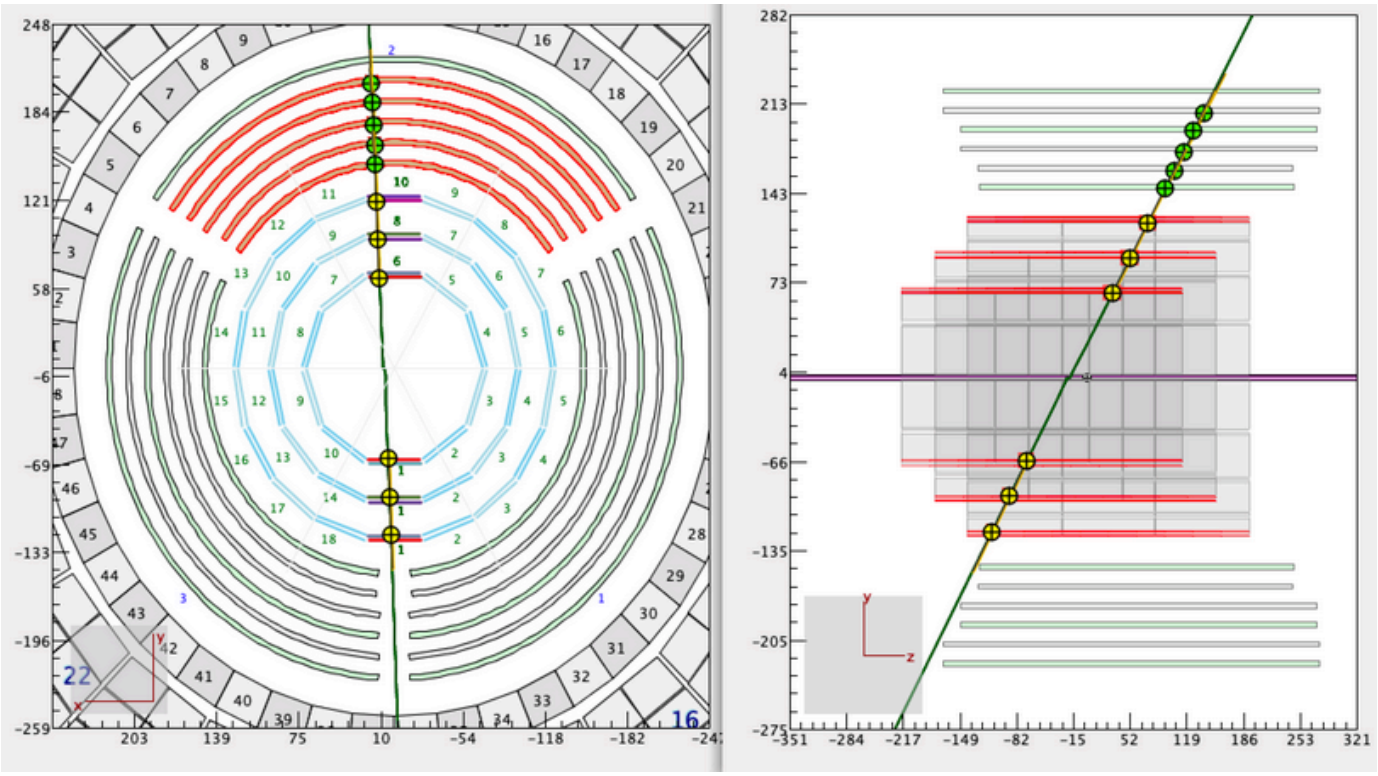


CVT assembled in the EEL building

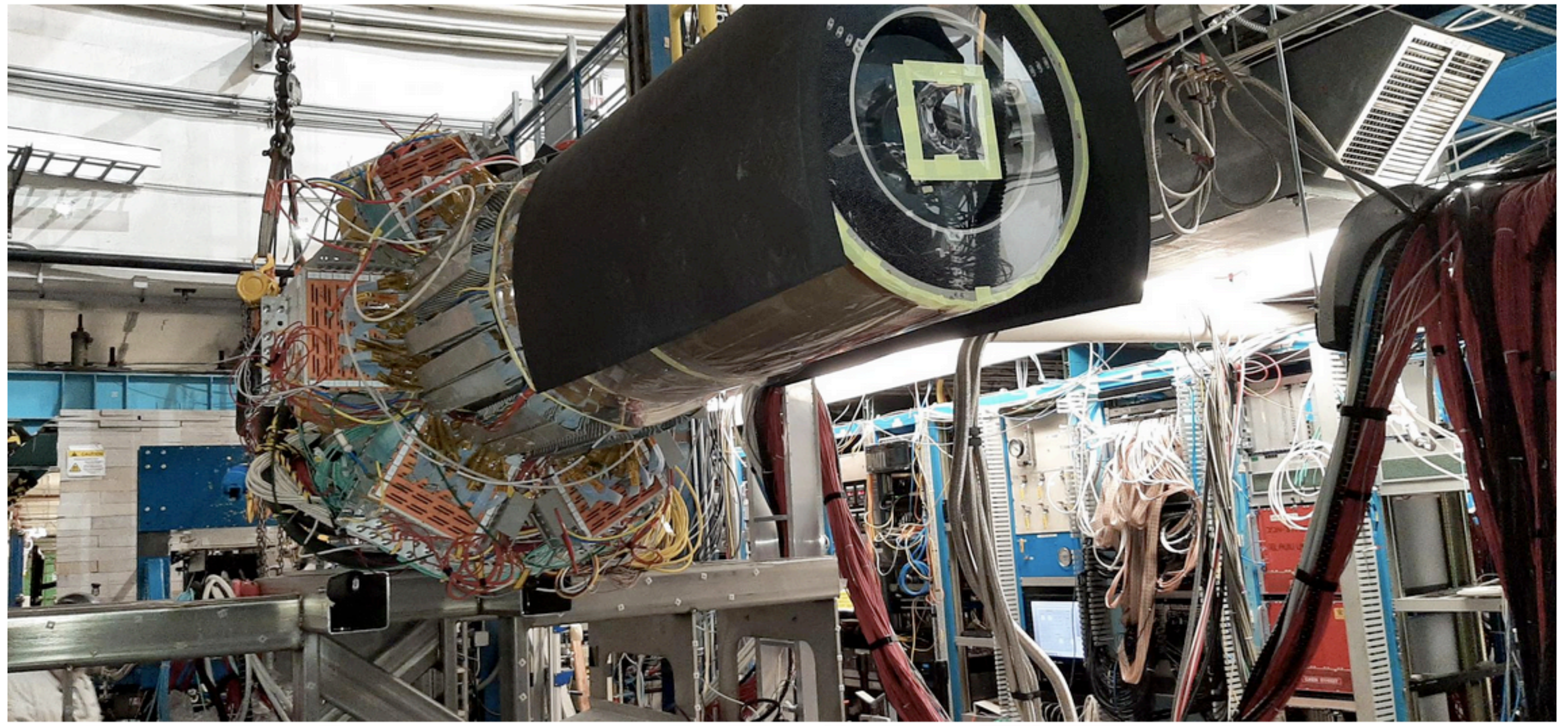
CVT fully cabled



CVT under commissioning with cosmic rays



CVT installed in CLAS12



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

2022: RG-C

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					

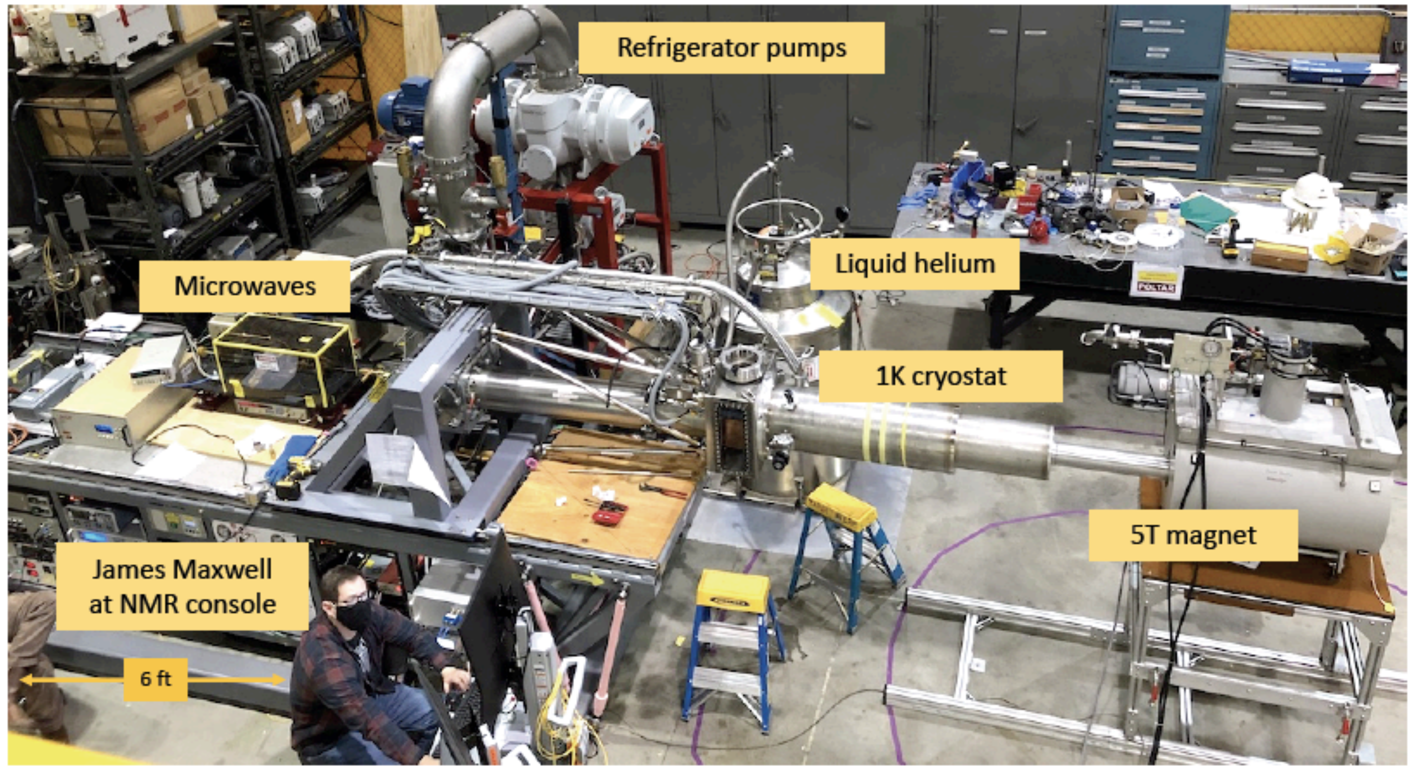
RGC: - Originally approved for 185 days of beam time

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

- Run plan: 90/120 PAC days FT-Off configuration; 30/120 PAC days FT-On configuration
- May 2 - Dec 20 2021
- Installation/preparation plan defined (+2 months for DNP target)
- New tungsten Moller cone, optimized raster size and target geometry: DC occupancies comparable to the simulations for RG-A

Longitudinally polarized targ

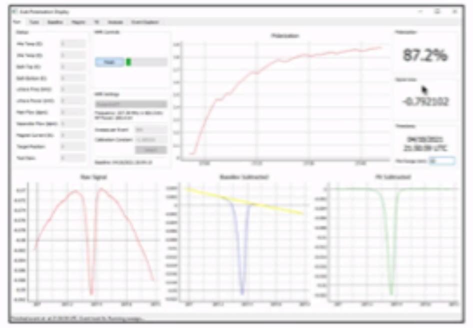
Latest tests in the Target Lab, April '21



NOT SHOWN
- James Brock
- Chris Carlin
- Tsuneyo Kageya
- Chris Keith
- Victoria Lagerquist
- Pushpa Pandey
- Xiangdong Wei

Longitudinally polarized target

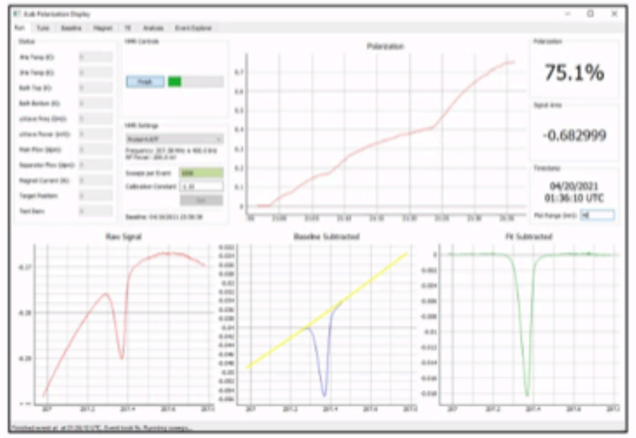
High Dynamic Polarization
- Butanol + TEMPO



Butanol reached +87% in about 50 minutes

Longitudinally polarized targe

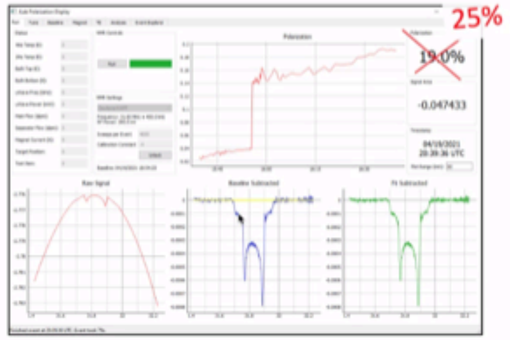
High Dynamic Polarization
- Irradiated NH3 (courtesy of UVa)



- No serious attempt to measure TE signal of ammonia sample, too slow
- Use same NMR calibration constant for butanol
- *75% in ~40 minutes*

Longitudinally

High Dynamic Polarization
- Deuterated-butanol + TEMPO



- Measuring the TE signal of d-butanol was hopeless (<0.1%)
- *Polarization can be estimated by the relative heights of the two peaks*

Credit: C.Keith, V.Burkert

Spring 2022: RICH-II

MAPMTs and ELECTRONICS *(made in Japan)*
391 Hamamatsu MAPMTs, 8x8 matrix, 25024 pixels in total, 1 m^2
374 out of 391 are at Jlab. Characterization completed. Quality is extraordinary (gain, quantum efficiency, dark current)

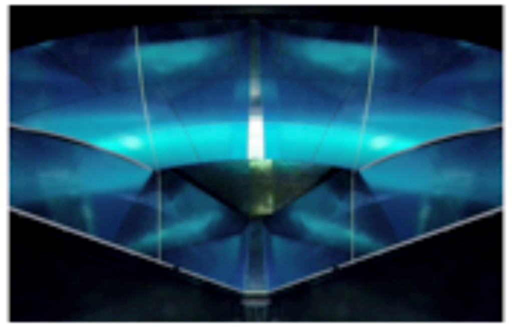
Mirrors: *10 plane mirrors (Italy) and 10 spherical mirrors (U.S.A.)*
All 10 plane mirrors re produced. One spare in the final assembly stage. Spherical mirrors are in production stage. Expect the delivery of first one in a month or two for quality control.

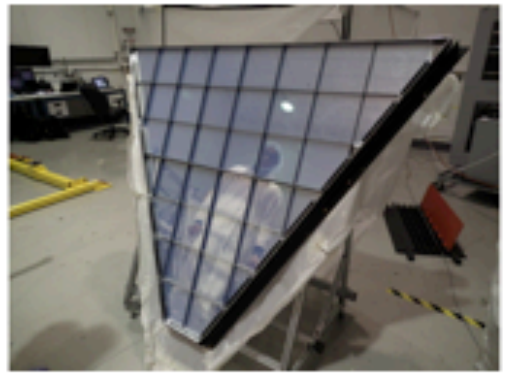
Aerogel *(made in Russia)*
2 cm tiles are complete. 3 cm tiles are in work. Producer still has problems with raw aerogel production. Expect to finish in June-July. Dry cabinet for aerogel storage arrived and installed in Jlab. Ask producer to send ready to go tiles to U.S.A.

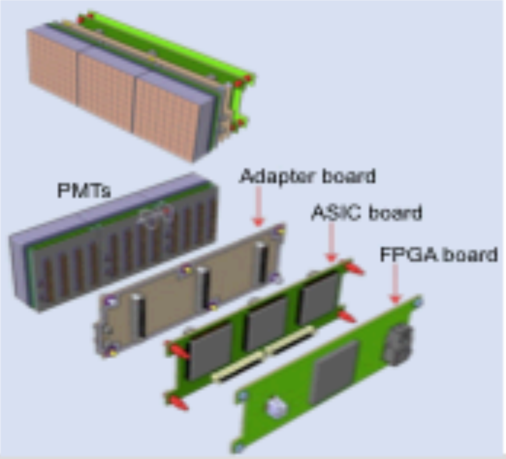
Mechanics *(made in Italy)*
Two boxes with almost all mechanical parts arrived to Jlab. Working on complements. Working on improving the gas tightness of the electronic panel

Electronics *(made in Italy and Jlab)*
Most of the front-end panels are at Jlab. Missing quality tests done in Ferrara, 30% tiles need rework. Expect to finish during two months. Working on the orders of HV main frame, fibers, cables, DAQ boards, slow control…

1







Next steps:

- ✳Photomatrix assembly. Can be done with minimum Italian engineers intervention
  - HV, LV, slow control, Interlocks, cables, fibers, DAQ electronics have to be ready
  - Test active part of the detector before the RICH assembly with cosmics
- ✳Test all planar and spherical mirrors in Jlab (surface quality and reflectivity)
- ✳RICH assembly and test in the clean room before transportation to Hall-B

The final goal is to be ready by May 2022

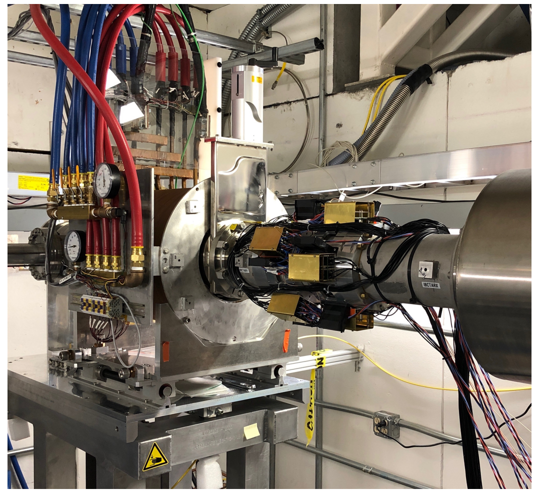
Credit: V.Kubarovsky

- In support of CLAS12 run group

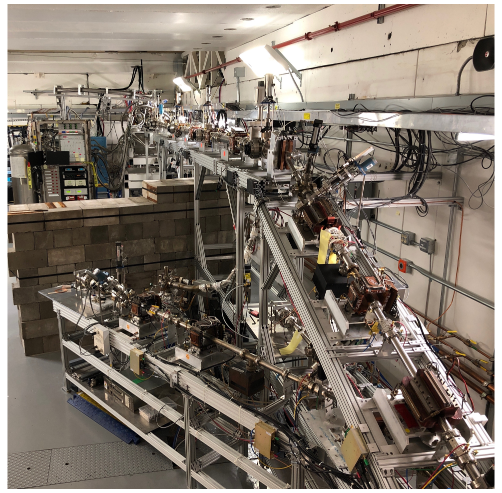
small B•dL ⇔ frozen-spin HD

HDice target tests at UITF necessary to check depolarisation effects

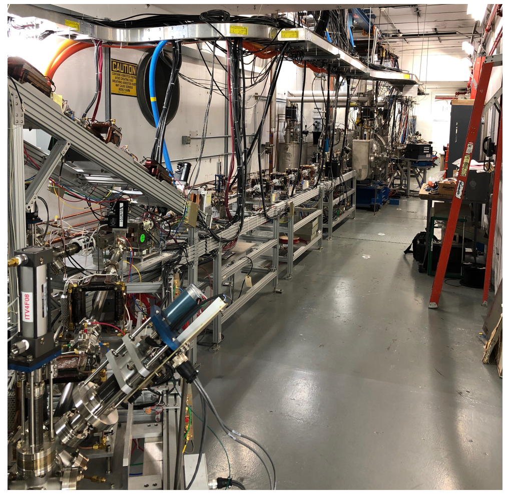
Work plan
- Run 0: booster at 0.5 MeV, 1 MeV, and 10 MeV
- Run 1: commissioning (beam line) ~19 days
- Run 2: run on UNpolarized HD ~17 days
- Run 3: run on Polarized HD ~28 days
- [Run 2b: calibration purpose currently running]



HDice In-Beam Cryostat



cave-2 elevated beam line



cave-1 with BOOSTER

HDice UITF tests summary

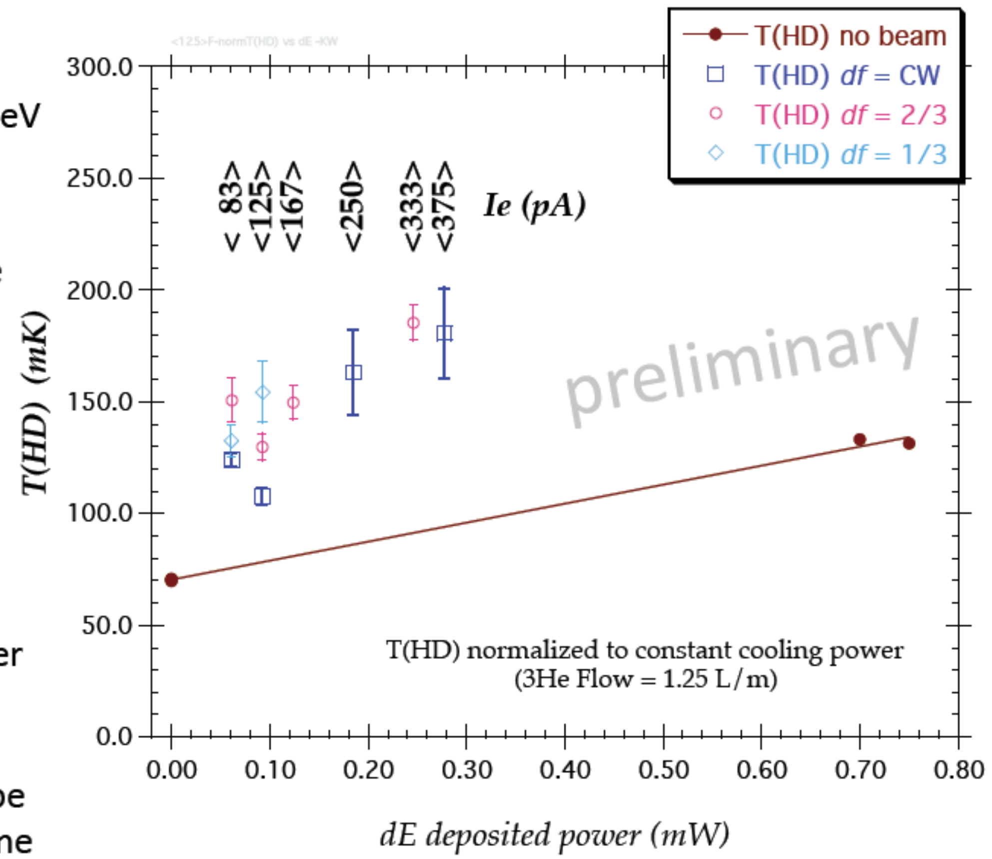
the present state of HDice is not able to support the required RG-H luminosity

Run 2b (Mar 02 – Mar 13/21)

Goal: measure NMR signals from a short-T_1 HD target that rapidly reaches an equilibrium polarization determined by the field and temperature, and use these to deduce the HD temperature under different beam conditions and duty factors

- Monday, Mar 1: short-T_1 HD target loaded into IBC
- Tuesday, Mar 2: cave-2 roof reinstalled; re-established orbit through IBC axis
- UITF running Mar 3 - 13
  - overall, UITF beam is much more stable than Fall/20, provided VTA is not drawing LHe !
  - UITF running conditions:
    - CW
    - USER MODE with *df* = *2/3* (3.33ms ON + 1.67ms OFF)
    - USER MODE with *df* = *1/3* (3.33ms OFF + 1.67ms ON)
- - NMR noise is significant when the UITF is operating
  - ⇔ each beam condition required hundreds of NR sweeps to average out noise
  - ⇔ ~ 1 day / point
- extract HD target from IBC: Monday 3/15; begin warmup of IBC

- from Run 2a (Nov/20):
  Eloss = 0.74 MeV
  = 0.74 mW/nA at 9.7 MeV
- initial Run 2b observations:
  - T(HD) ~ order of magnitude larger than expected
  - ⇔ unpaired electrons are partially unpolarized
  - ⇔ will decrease T_1 of frozen-spin targets
  - reduced *df* with the same average <Ie> results in higher temperatures than CW
- analysis is ongoing; we may be able to extract info on the time constant for heat removal from HD



Credit: A.Sandorfy, X.Wei, C.Hanretty, T.Kageya, M.Lawry

CLAS12 ~2025: RG-H - Transverse polarized target Hall B

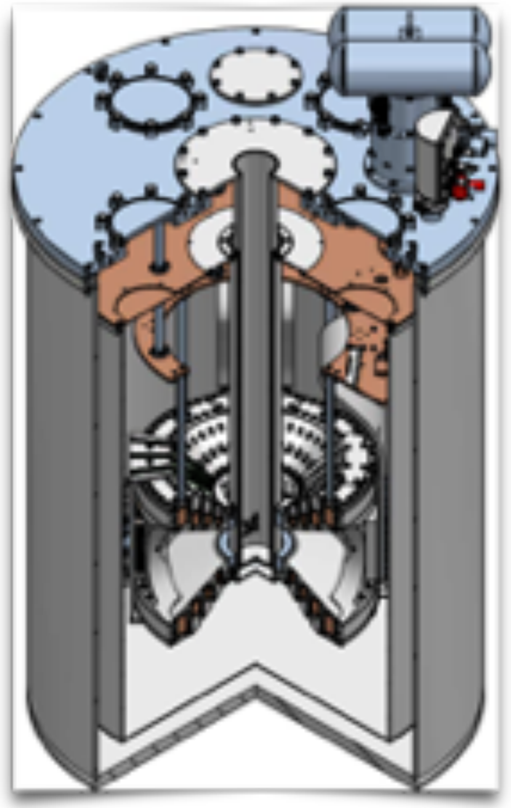
Transvere Polarized target

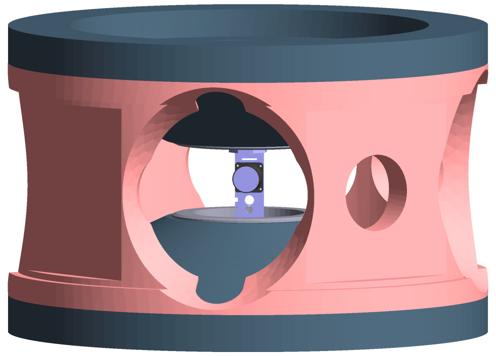
- HDIce does not demonstrate to be able to support RG-H physics program (unfortunately!)
- Identified NH_3/ND_3 DNP target as an alternative
- Modification of Hall-A/C DNP target with a new to 1K refrigerator to fit CLAS12
- Two compact superconductor magnets to compensate the target transverse field on incoming beam
- Detailed model of target field implemented
- With the current shielding configuration $L=1\times10^{33}$ $cm^{-2}s^{-1}$ is achievable
- The shielding optimisation is in progress
- RG-H + Software Group expected to run full simulations to evaluate the impact on physics

Physics impact

- A Reduction in luminosity from 5×10^{33} $cm^{-2}s^{-1}$ to 1×10^{33} $cm^{-2}s^{-1}$;
- Increase in polarization from 60% to 80%;
- Change in the dilution factor from 1/3 to 3/17;
- Operating 5 sectors (instead of 6) of CLAS12 Forward Detector due to electromagnetic background;
- Removing the Forward Tagger covering small angle photons (this only affects the DVCS program);
- Removing the CLAS12 Central Detector (this only affects the DVCS program).

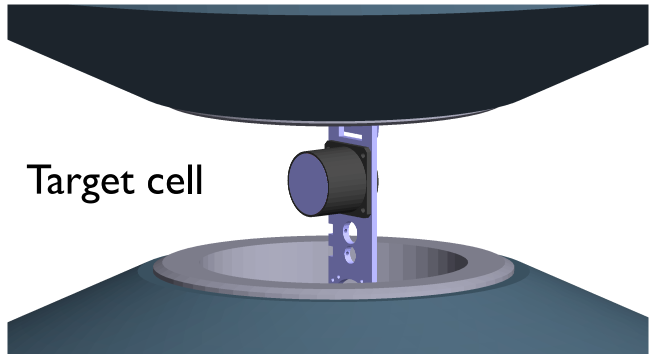
New cryostat



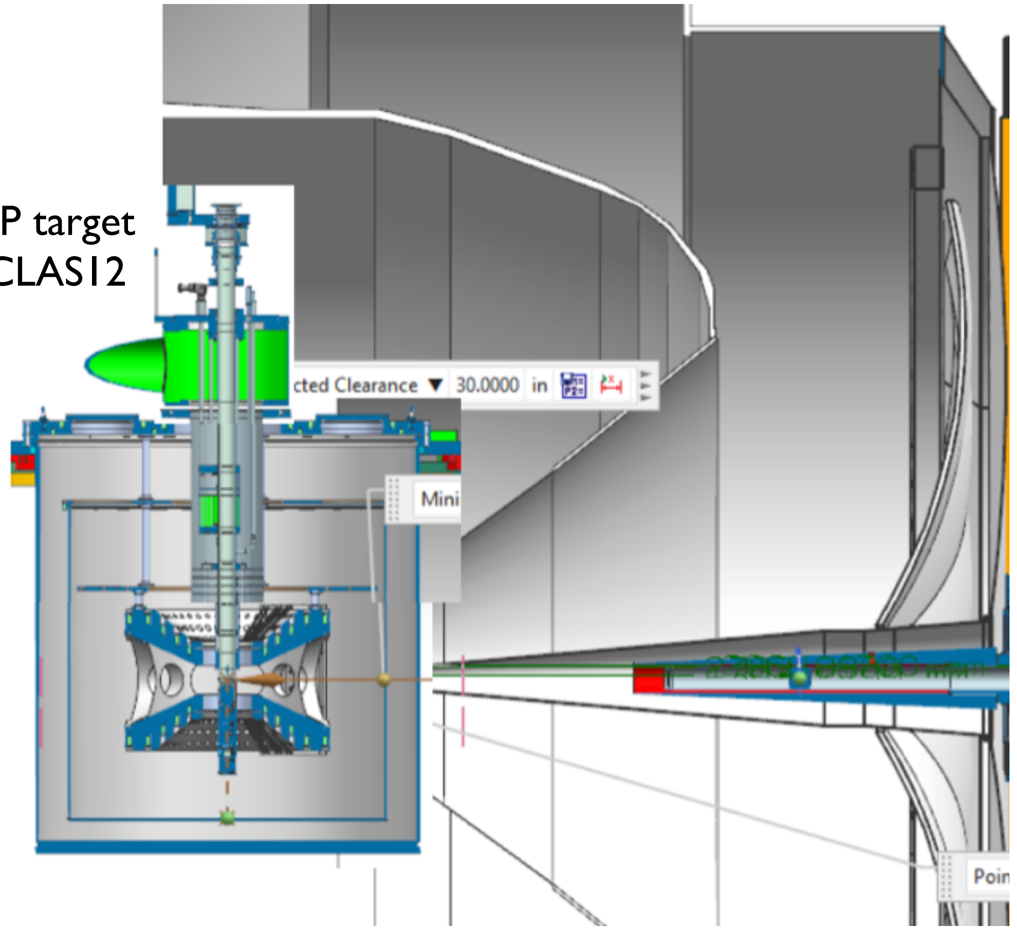


Transverse magnet model

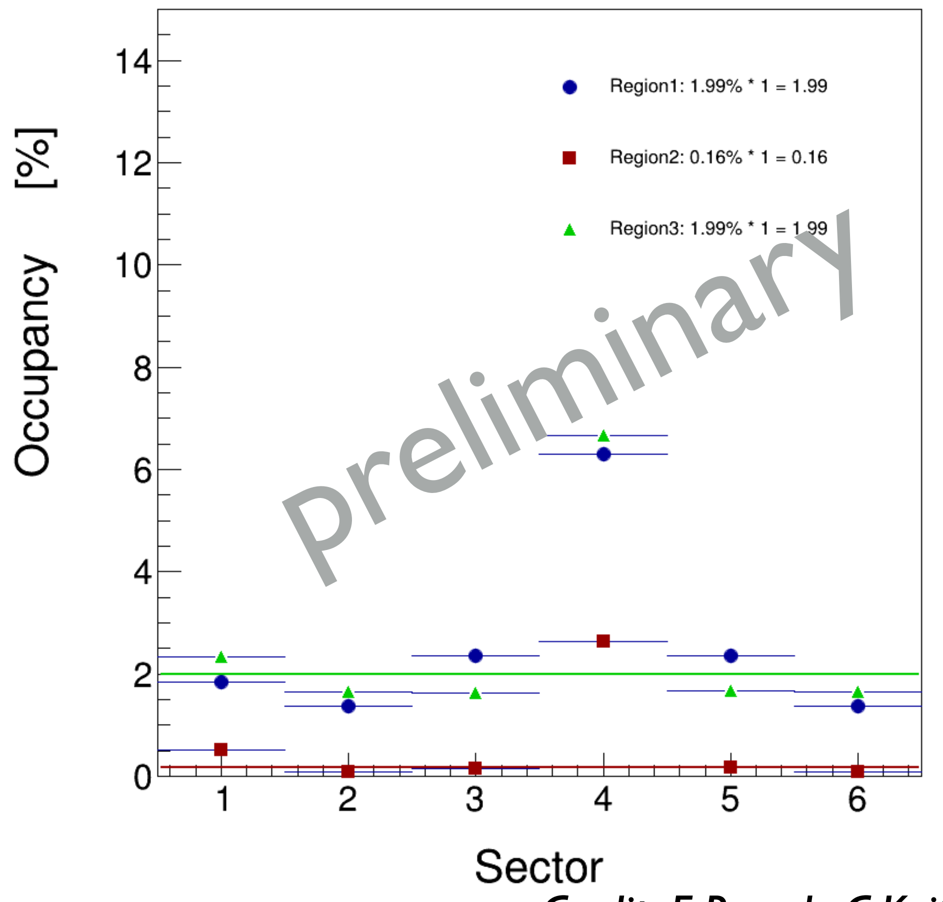
Target cell



DNP target in CLAS12



Particle background in CLAS12



Credit: E.Pasyuk, C.Keith

RG-L (ALERT) Status

ALERT ERR Apr. 7, 2021

Agenda [edit]

8:30-8:45 Executive Session

8:45-9:30 Overview presentation and integration in CLAS12 (Tom O'Connor) - charges 1. and 5.

9:30-9:50 The target system (Mohammad Hattawy) - charges 1.b and 6.

9:50-10:30 The Hyperbolic Drift Chamber Mechanics / Readout and physics prototypes (Julien Bettane, Gabriel Charles) - charges 1.a and 3.c

10:30-10:45 Coffee Break

10:45-11:30 The ALERT TOF (Whitney Armstrong) - charges 1.c, 2. and 3.c

11:30-11:45 Safety, radiations and documentation (Gabriel Charles) - charges 3.a., 4., 7., 9. and 11.

11:45-12:15 Simulations, software and computing (Michael Paolone) - charges 3.b, 3.d and 10.

12:15-12:45 Schedule and organization (Raphael Dupre) - charges 1., 8. and 10.

12:45-14:00 Working Lunch

14:00-17:00 Executive Session

17:00 Closeout

Main Recommendations from ERR (and focus of current efforts):

1) TOF:

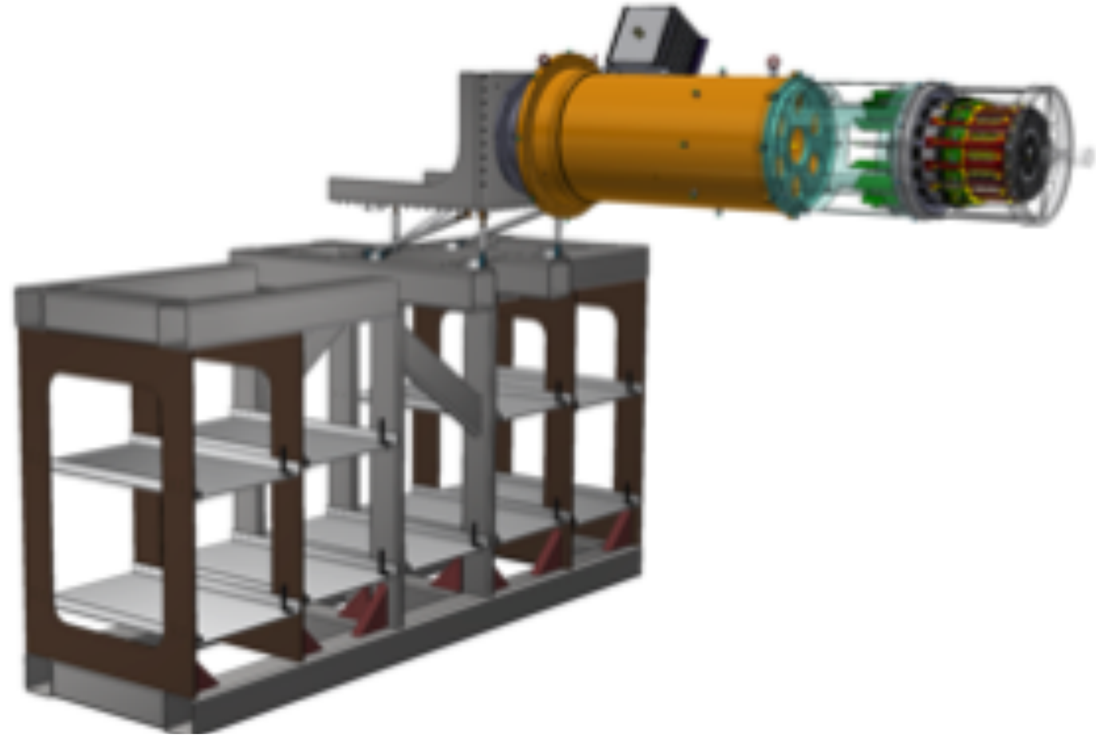
- Construct a prototype of one TOF module (with all 4 30-cm-long scintillator paddles and 40 scintillator wedges) including the SiPMs - demonstrate that light output is sufficient to achieve the expected operating parameters and required timing resolutions using the full readout electronics chain

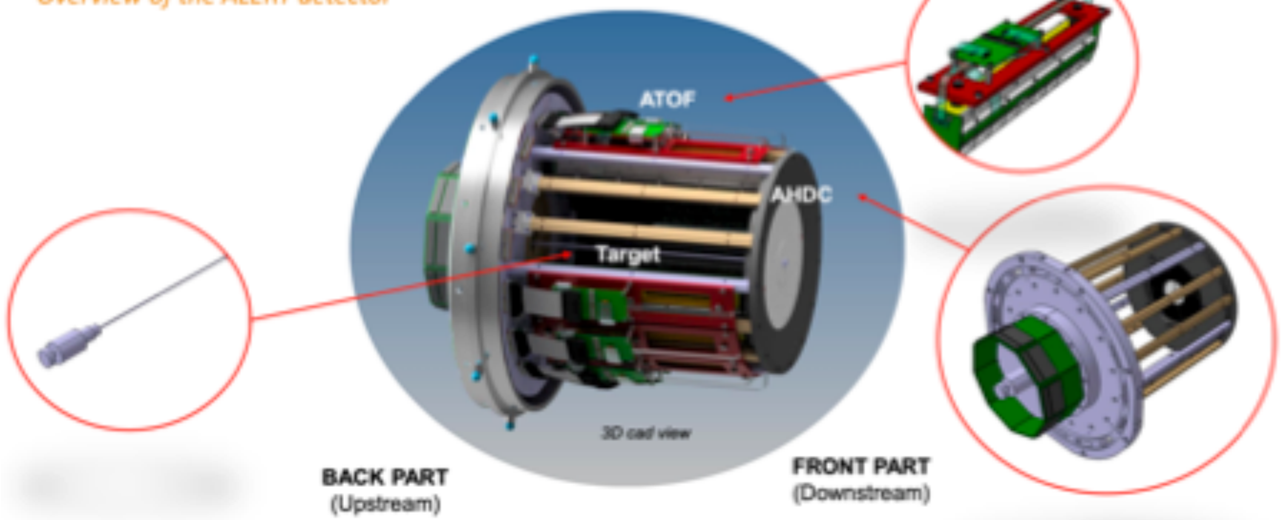
2) HDC:

- Provide a plan that will demonstrate the operating parameters for the HDC (using prototype chamber) within the 5 T solenoid field
- Implement these tests in January 2022 at Argonne with the prototype test chamber

3)Radiation:

- Perform realistic estimates to determine the neutron radiation at the SiPM location





Working to address recommendations from ERR by the end of June – goal to submit beam time request this summer

Credit: D.Carman + ALERT team

- Virtual meeting: July 19 - 23 2021

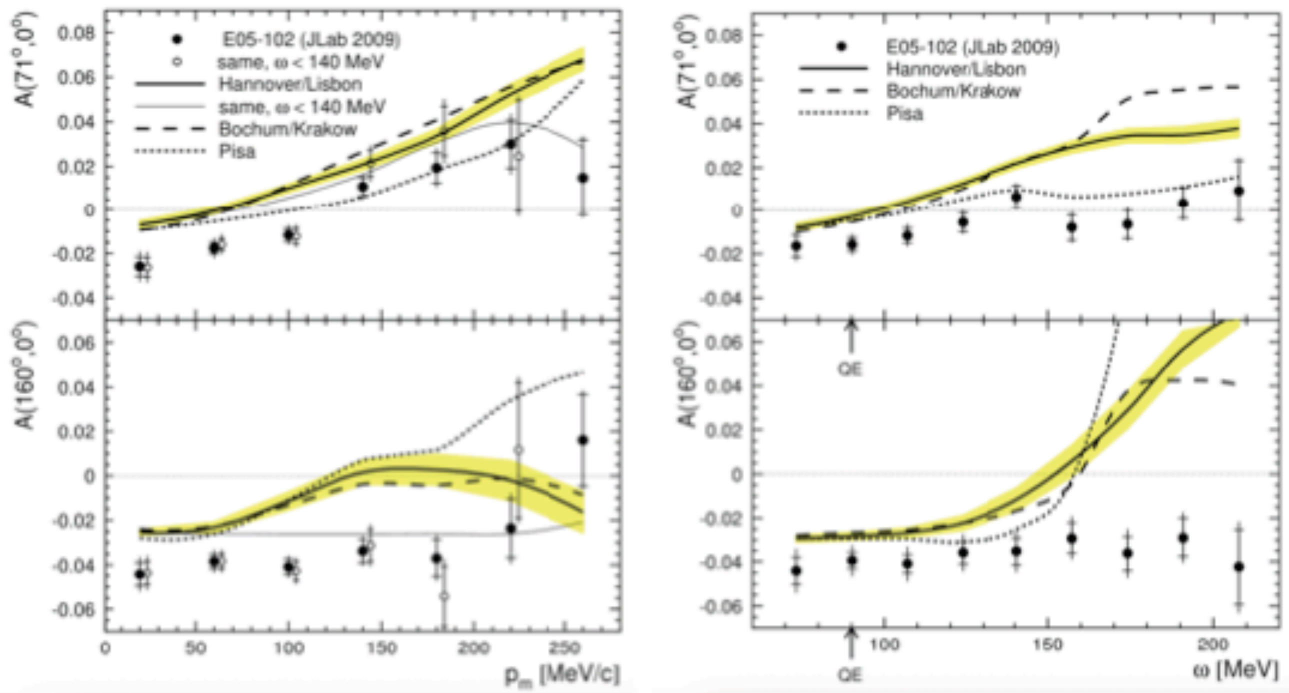
Proposal ID	Hall	Title	Contact Person		Days	Topic
Letters of Intent						
LOI12-21-001	C	3N Short-Range Correlations	Nadia Fomin	fomin@jlab.org	n/a	5
LOI12-21-002	A	Measurement of the Tensor Observable Azz using SoLID	Elena Long	elena.long@unh.edu	19	5
LOI12-21-003	B	Exploring fundamental properties 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	weinstei@jlab.org	58	1
PR12-21-005	A	Double Spin Asymmetry in Wide-Angle Charged Pion Photoproduction	Bogdan Wojtsekhowski	bogdanw@jlab.org	n/a	4
PR12-21-006	A	Measurement of the Asymmetry A^{e+e-}_d between e^+-^{2}H and e^-- ^{2}H Deep Inelastic Scattering Using SoLID and PEPPo at JLab	Xiaochao Zheng	Xiaochao@jlab.org	104	6
New Run Group Proposal						
PR12-21-007	A	TDIS-n: Tagged DIS Measurement of the Neutron Structure Function	Arun Tadepalli	arunts@jlab.org	27	3

Credit: D.Higinbotham

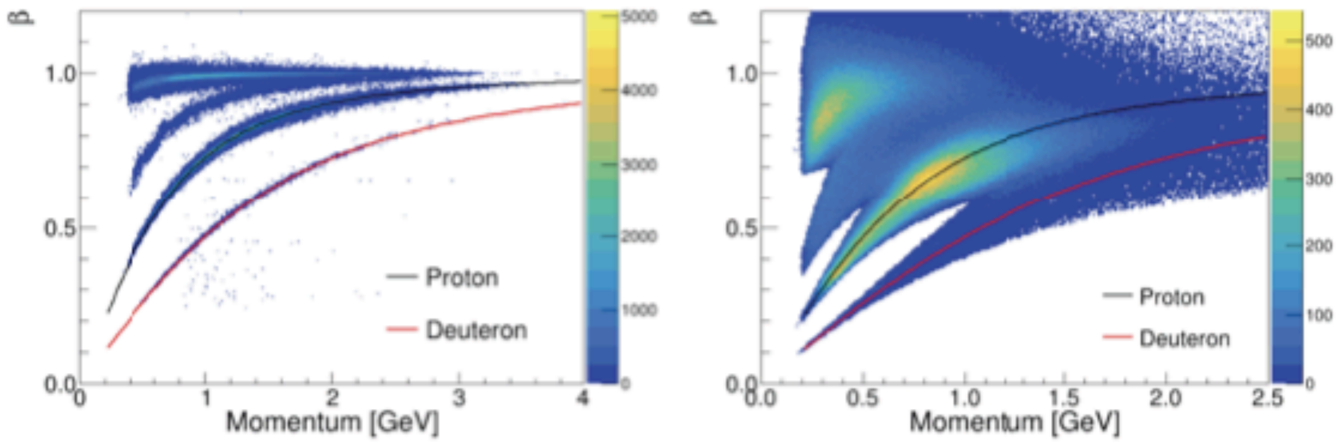
Exploring fundamental properties of ^{3}He through the polarized ^{3}He(e,e'd) process in CLAS12

Letter of Intent

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



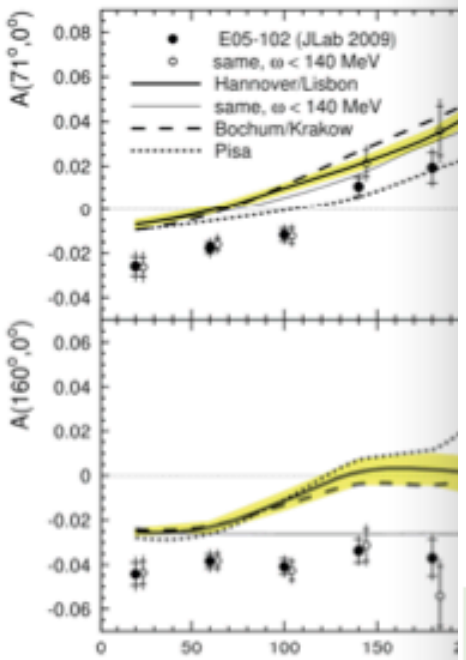
State-of-the-art three-body calculations unable to explain new Hall A data (see references below).



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)

- 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.

th



State-of-the-art three-body c

- Hall A results
  - M. Mih
  - M. Mih
- The problem
- By taking dat
- Experiment v
- Results are ir

Credit: Z. Ye

SIDIS Experiments with A=3 Nuclei using CLAS12

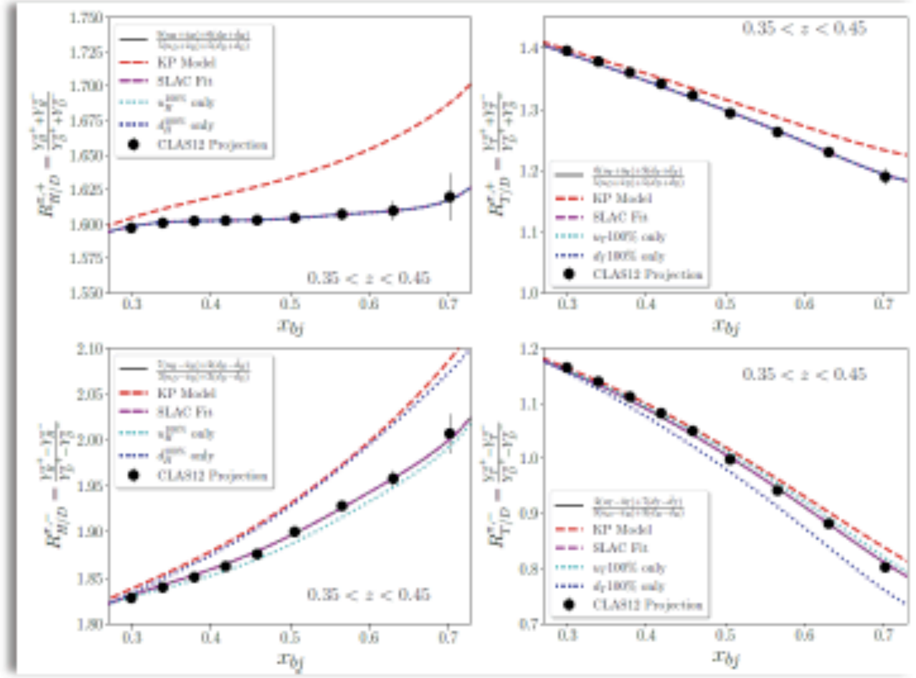
Spokespeople: D. Dutta, D. Gaskell, O. Hen, D. Meekins, D. Nguyen, L. Weinstein, J.R. West, Z.H. Ye

- 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

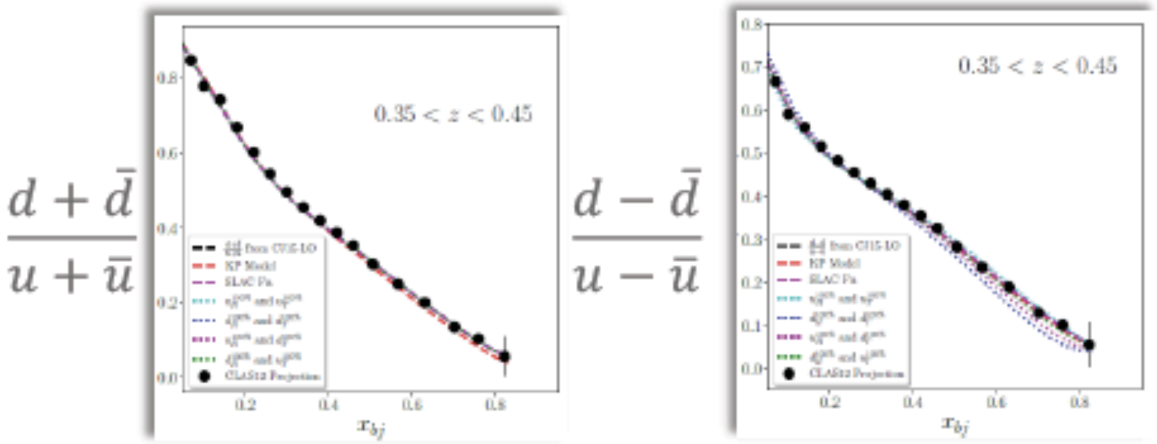
I. Cloet, et al, PRL 109, 182301 (2012); PRL 102, 252301 (2009)]

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

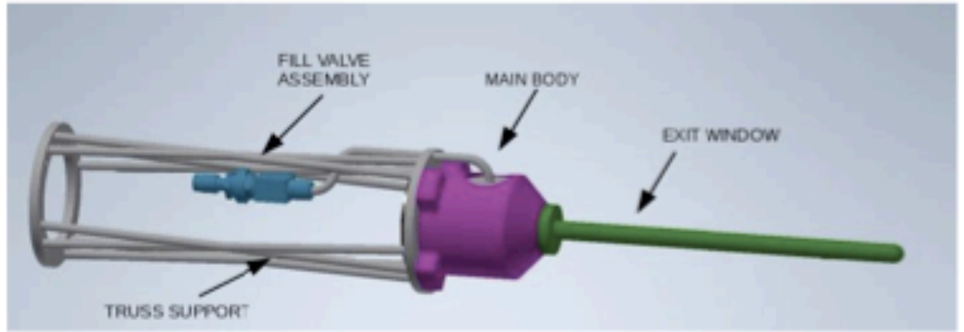
- ✓ Probe the iso-spin dependence of the EMC effect
- ✓ Directly study the EMC effects of u- and d-quarks in A=3
- ✓ Fragmentation Functions (FFs) should be small and largely cancel in ratios



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

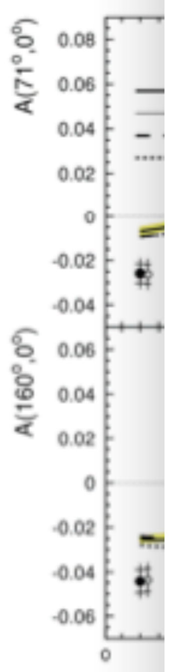


- Precision Measurements of the A=3 TMDs and FFs in 4D (Q2, x, z, pT) binning
- Study Strangeness Contents in A=3 with kaons (if RICH)
- Experimental Settings:
  - ✓ Standard CLAS12 Configuration
  - ✓ Same target system in Tritium-SRC (E12-20-005)
  - ✓ 50 days of physics (D2, H3 and He3), 8 days calibration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



SIDIS Experiments with A=3 Nuclei using CLAS12

Credit: Z. Ye



State-of-t

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, 2.5×10^{-4} r.l.
  density: 16.69 g/cm^3
  N(Ta) = $0.56 \times 10^{+19}$ 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 $0.7 \times E_{beam}$];
- decay e- and e+ are in the $PbWO_4$ within energy: [0.03 – $0.8 \times E_{beam}$]
- Target to PbWO4 distance L=7.5 m beam energy optimized for E_e = 2.2 GeV and 3.3 GeV

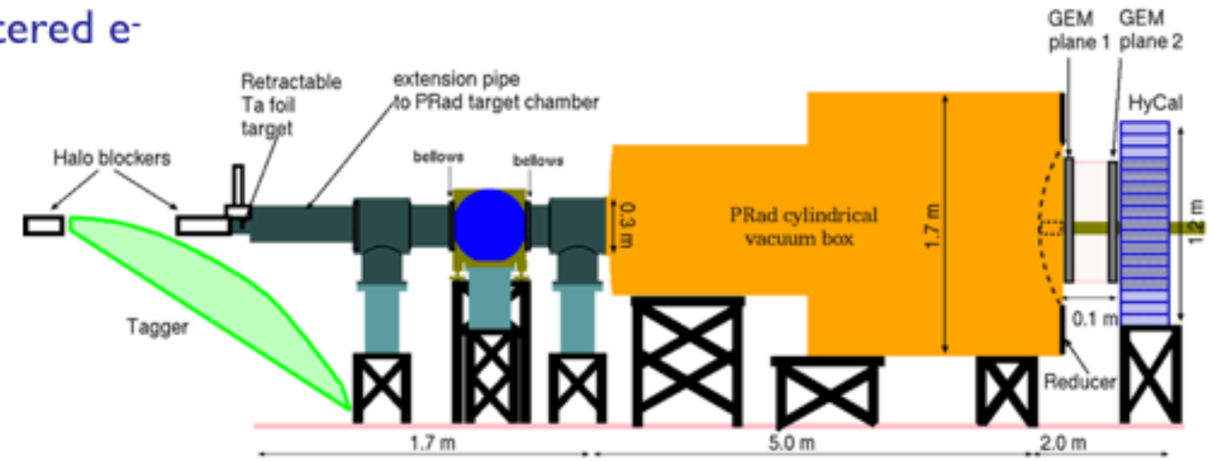
Beam time request

	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

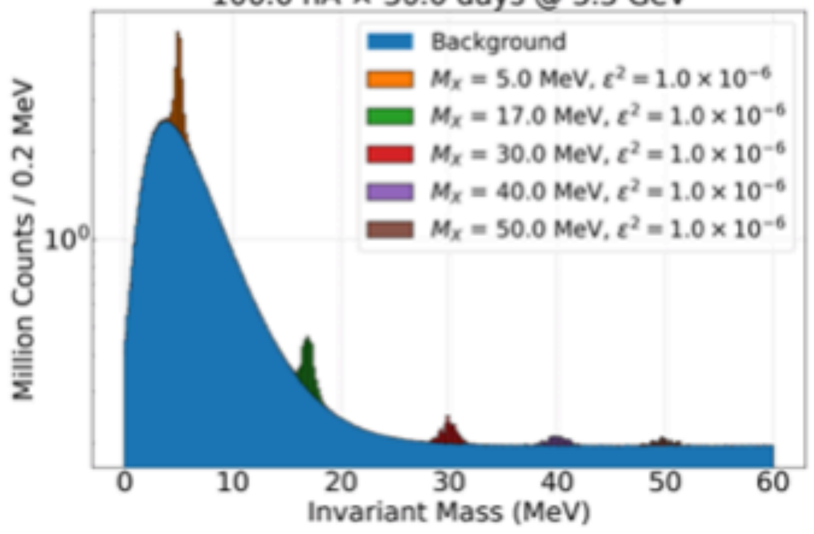
Search sensitivity

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

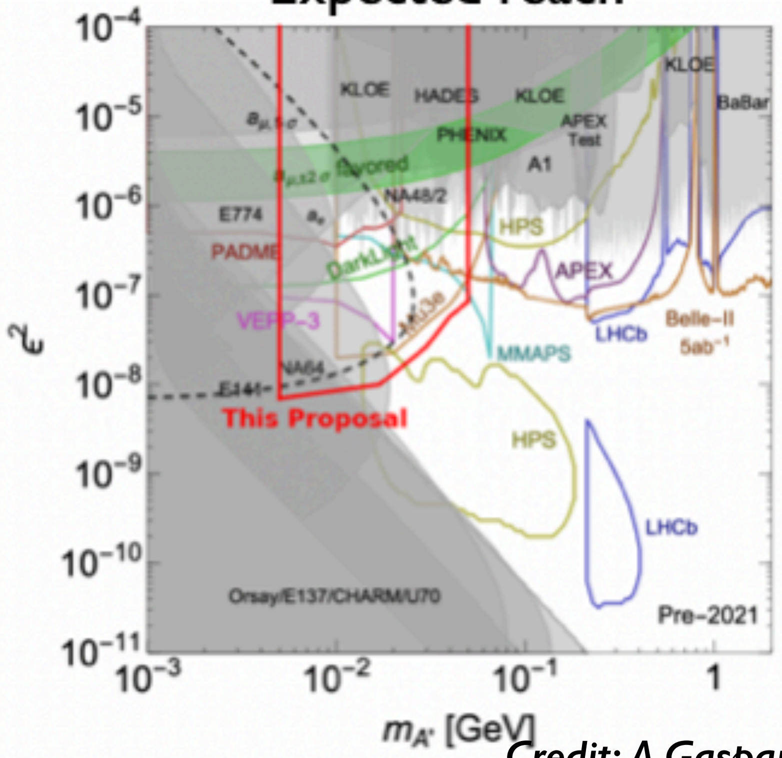
Experimental Setup (Side View)



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



Expected reach



Credit: A.Gasparian

CLAS12 — CLAS12 Hi-Luminosity: detector — Hall B

Summary: Goals for the Upgrades

- **Stage-1:** Achieve luminosity of $2{\times}10^{35}cm^{-2}sec^{-1}$ for normal CLAS12 running with charged particle reconstruction efficiency of >85%

Can be achieved within 3 years with budget of $~2M.

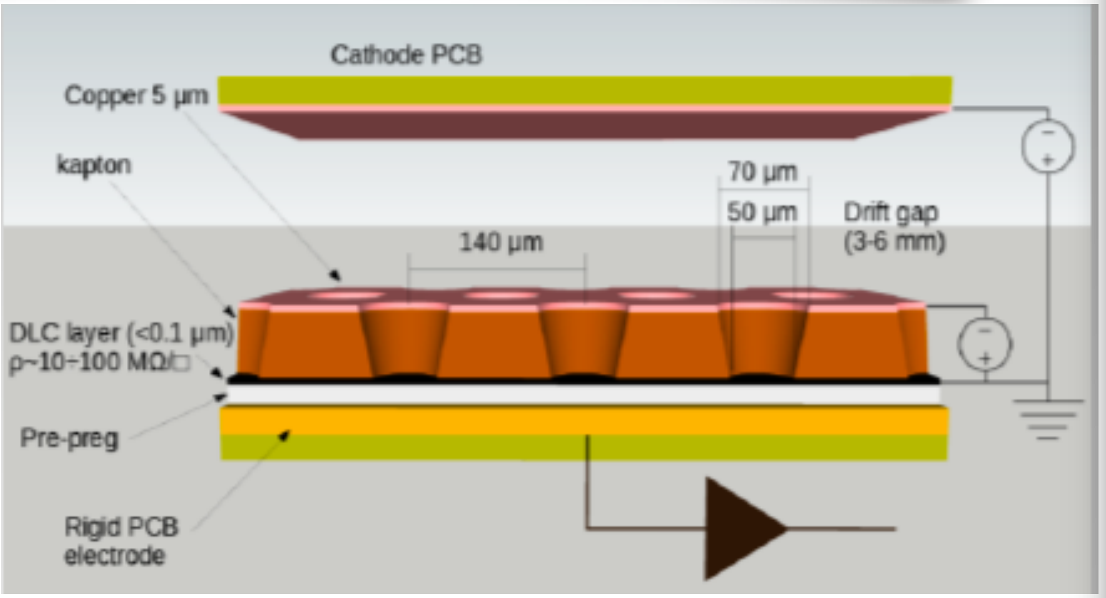
- Stage-2: Define a configuration of CLAS12 operations for two orders of magnitude higher luminosity, $> 10^{37}cm^{-2}sec^{-1}$

More MC studies, detector R&D and engineering are needed. TF conclusion, can be done in 7-10 years time frame with under $10M budget.

CLAS12 at Hi-Lumi Task Force (PI: S.Stepanyan)

- CLAS12 Hi-Lumi in the lab agenda
- Two-stages work-plan: I) Lx2, II) Lx100
- Focus on Stage I: Achieve luminosity of ~ $2{\times}10^{35}$ $cm^{-2}s^{-1}$ for normal running conditions of CLAS12 with charged particle reconstruction efficiency of > 85%
- new tracker (GEM, uRwell) to replace DC (+improved FE electronics)
- Preliminary work plan aiming to develop a detector in ~1y time and test it on-beam in CLAS12

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

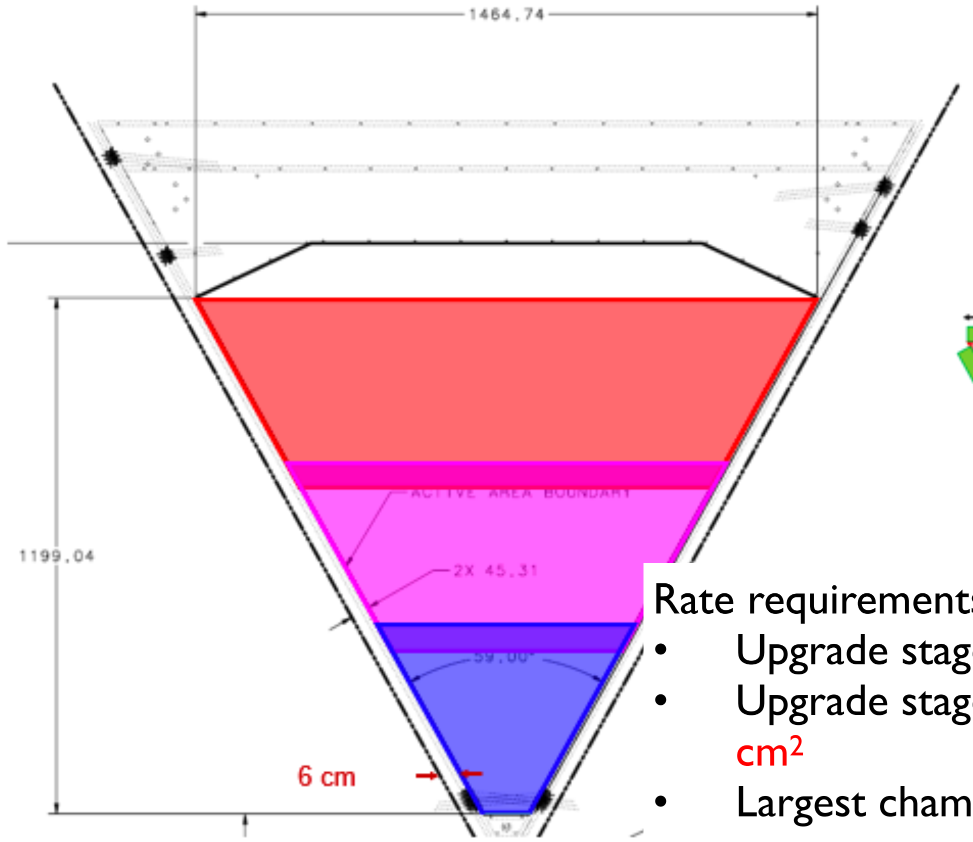


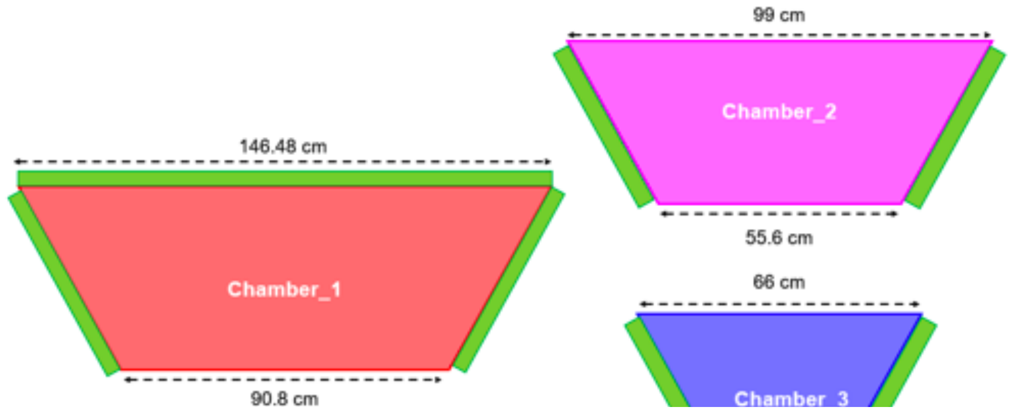
The performance
- Gas gain: 10^4
- Rate capability HR version: 10 MHz/cm2
- Rate capability LR version: 100 kHz/cm2
- Spatial resolution: down to 60 μm
- Time resolution: 5-6 ns

CLAS12 Region-I μRWELL Detectors

- Expected rate:
  - Upgrade stage 1: average 5 kHz / cm², maximum rate ~7kHz /cm²
  - Upgrade stage 2: average 15 kHz / cm², maximum rate ~20kHz / cm²?
- Largest chamber 1500 cm x 50 cm

μ-RWELL prototyping
- UVa (INFN support)
- Simulations in GEMC





Rate requirements:
- Upgrade stage 1: average 5 kHz / cm², maximum rate ~7kHz /cm²
- Upgrade stage 2: average 15 kHz / cm², maximum rate ~20kHz / cm²
- Largest chamber 1500 cm x 50 cm

Credit: S.Stepanyan

CLAS12 CLAS12 Hi-Luminosity: detector Hall B

DAQ upgrade up to 100kHz event rate

- Trigger-based mode is used
- FADC250, DCRB, VSCM, SSP boards will stay
- CAEN TDCs have to be replaced with VETROCs, VME crates to be converted to VXS
- MM readout to be decided, proposed solution is new VMM3 ASIC based board, work in progress with MM team
- SVT ASIC performance have to be validated for high luminosity running
- Some VTPs have to be used as both trigger and readout modules, firmware under development (reason is limited VME readout bandwidth)
- Some boards firmware and CODA software have to be validated and may need to be modified/fixed
- CODA software (EB in particular, also ET and ER) have to be able to process higher rate, may need improvements
- Work can be performed in steps, with partial performance improvement on every step
- Time scale 2 years

DAQ upgrade to streaming

- VTP, FADC250, DCRB, VSCM, SSP, VETROC boards can be reused, or/and new non-vxs based electronics can be used
- Exact streaming DAQ configuration for CLAS12 to be decided during following years based on available technology
- All new electronics development (ASICs etc) have to be compatible with streaming mode
- New streaming version of CODA is needed – not available at current time, switching to streaming DAQ can be considered only when back-end is available or close to become available
- Time scale 3-5 years depending on demand

Front-end electronics upgrade to streaming mode is underway, no serious problems anticipated

1. CLAS12 Future DAQ and Trigger Systems

Sect.1: timeline, milestones, dependences, resources, funds

Review 0.0 December 2020

Goals *Study the possible improvements of the CLAS12 DAQ and Trigger Systems, make an upgrade plan, and start actual implementation*

Task Force		CLAS12 Future DAQ and Trigger Systems												
PI		S.Boyarinov, G.Heyes												
Members		V.Kubarovsky, R.Paremuzyan, N.Baltzell, G.Gavalian, B.Raydo												
Tasks/Subtasks		2020		2021									2021/22	2022
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct-Mar	Mar-Sept
1. Trigger-based DAQ upgrade to increase event rate limit to 100kHz:														
1.1 CAEN to VETROC TDCs												M1.1		
1.2 MM readout upgrade									M1.2					
1.3 VME to VTP readout									M1.3					
1.4 DAQ software upgrade											M1.4			
2. Trigger system upgrade to improve existing setup and develop solutions for streaming DAQ:														
2.1 Upgrade existing trigger system						M2.1								
2.2 Implement L3 trigger							D1							
3. Streaming DAQ development:														
3.1 Build/support test setups													M3.1	
3.2 Assist in backup solution development						M3.2								
3.3 Prepare plan for streaming DAQ implementation in CLAS12											M3.3			

Milestones list *(at least one per task)*
M1.1: All hardware purchase
M1.2: MM upgrade plan review
M1.3: ready to be used in Hall A
M1.4: 100kHz pulser test for equipment which will be reused
M2.1: finish r&d for timing usage in dc segment finder for trigger, decide if it is useful
M2.2: DEPENDENCE L3 design (after some results from M2.1 + EC clustering improvements etc)
M3.1: FADC enhanced, DCRB streaming
M3.2: smart switch software model (aggregator)
M3.3: first complete plan

Dependences
D1: M2.2 depends on M2.1

Resources *(in FTE-year units only over the FY21, ignore tasks listed in FY22 and beyond)*

Hall B / JLAB

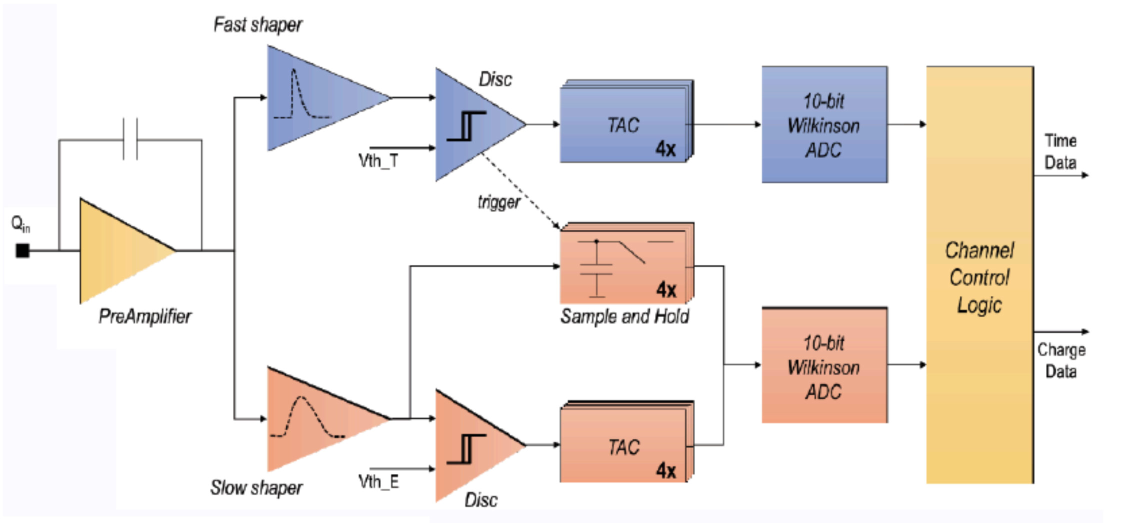
Name	S.Boyarinov	R.Paremuzyan	G.Gavalian	B.Raydo	tech	El.engineer				
FTE	0.5	0.5	0.25	0.3	0.3	0.3				

R-WELL DETECTORS FRONT-END ELECTRONICS

G.Felici - LNF

- APV
- VFAT3
- TIGER
- VMM3
- SAMPA
- FATIC
- lpGBT

TIGER BLOCK DIAGRAM



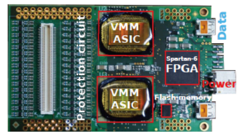
VMM3 (ATLAS MUON UPGRADES - MicroMegas & sTGC)

VMM3 – 64 chs

- Design
  - First rel: 2012-VMM3: 2016-130 nm
- Input Stage
  - Gain: 0.5, 1, 3, 4.5, 6, 9, 12, 16mV/fC
  - Shaping: 25, 50, 100, and 200 ns
  - Full baseline return: less than 600 ns
  - Detector Capacitance: few pF to 3 nF
- TIME DETECTOR
  - TAC circuit (threshold crossing/peak time - BC clock)
    - Ramp duration 60/100/350/650 ns)
- ADC
  - 6/8/10 bits - 250 ns conversion time
- READOUT MODE
  - Two-Phase mode: Acquisition + Readout
  - Continous mode: simultaneous R/W operation (4 MHz max rate x channel - 38 bits data - 4 events FIFO - 2 lines @200 MHz)
  - Lo mode: ATLAS RO (Latency); two serial lines @ 160 MHz Double Data Rate; 640 Mbits/s → 560 Mbits/s max BW including data encoding 8b/10b protocol)
- FAST OUTPUTS
  - Direct Data Output: ToT, TtP, PtT, 10ns pulse occurring at peak (PtP), address in Real Time (channel number of first hit), 6 bits low res ADC value (25 ns conversion time)

- MAX INPUT RATE
  - 4MHz (limited by the
- DATA OUTPUT
  - 38 bits/hit
  - 4 buffers
  - 2 data lines @ 200 MHz - DDR 800 Mbit/s Max
- RADIATION TOLERANCE
  - Single Event Upset & Total Ionizing Dose

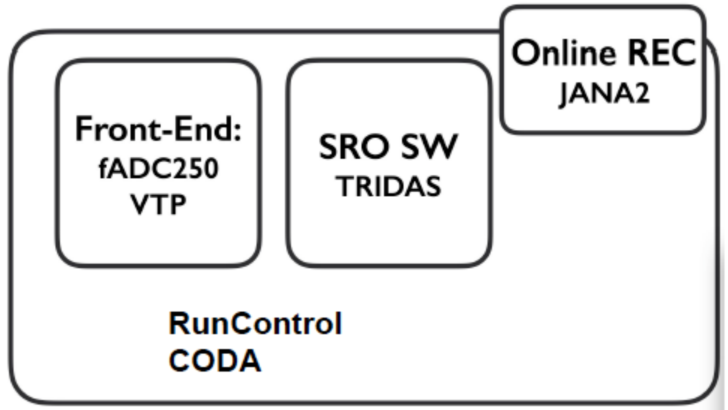
VMM3 Hybrid
(APV25 interchangeable)

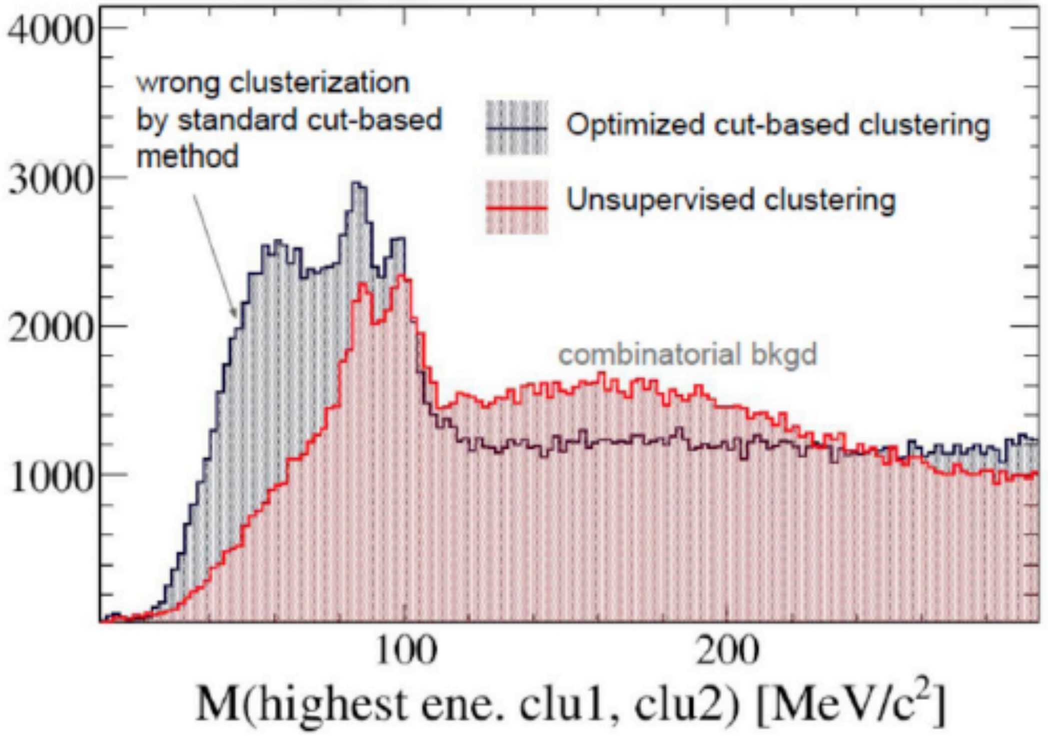


µ-RWELL readout

- two leading options under investigation: SAMPA (ALICE) and VMM3 (ATLAS)
- INFN involvement in MPD

Streaming RO CLAS12 FT tests: triggerless daq chain





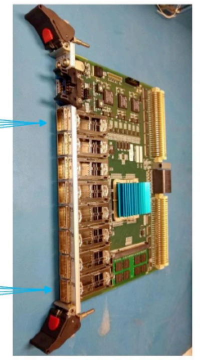
Farnesina Jefferson Lab INFN

MPD Optical Readout

SAD Activities – SBS GEM DAQ

MPD: Multi-Purpose Digitizer -INFN

SSP: Sub-System Processor - JLAB



VME readout @ 2eSST320
*240MB/s limit expected

Up to 32MPD per SSP
*less expected due to bandwidth limits

Optical cable:
1 SSP QSFP Port <-> 4 MPD 4 SFP Ports

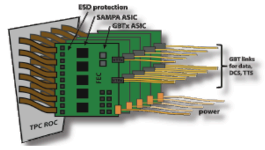
Thomas Jefferson National Accelerator Facility
Fast Electronics Group –Cuevas
2021 FEBRUARY 23
Page 13

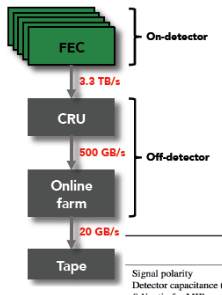
SAMPA ASIC (ALICE TPC RO)

Continuously read all ADC values (no compression)

Radiation hard data and control link: CERN GBT system

Online data correction (baseline fluctuations, common mode effect) and cluster finding in CRU (FPGA based readout card)





ALICE **Readout strategy**

		Run 1 (measured)	Run 3 (requirement)
Signal polarity		Pos	Neg
Detector capacitance (range)	(pF)	12 – 33.5	12 – 33.5
S:N ratio for MIPs (IROC)		14:1	20:1
(OROC 6×10 mm² pads)		20:1	30:1
(OROC 6×15 mm² pads)		28:1	30:1
MIP signal	(fC)	1.5 – 3[14]	2.4 – 3.2
System noise (at 18.5 pF, incl. ADC)		670 e	670 e
PASA conversion gain (at 18 pF)	(mV/fC)	12.74	20 (30)
PASA return to baseline	(ns)	< 550	< 500
PASA average baseline value	(mV)	100	100
PASA channel-to-channel baseline variation (σ)	(mV)	18	18
PASA shaping order		4	4
PASA peaking time	(ns)	160	160 (80)
PASA crosstalk		< 0.1 %[15]	< 0.2 %
PASA integrated non-linearity		0.2 %	< 1 %
ENC (PASA only, at 12 pF)		385 e	385 e
ADC voltage range (differential)	(V)	2	2
ADC linear range (differential)	(fC)	160	100 (67)
ADC number of bits		10	10
ADC sampling rate	(MHz)	10 (2.5, 5, 20)	10 (20)
Power consumption (analog & digital)	(mW/ch)	35	< 35

* ALICE TPC upgrade and the SAMPA asic [Christian Lippmann]

Credit: S.Boyarinov, M.Bondi, C.Cuevas, V.Gyurgyan, T.Chiarusi, C.Pellegrino, C.Fanelli, A.d'Angelo, …

CLAS12 future upgrades

JLAB upgrades

Future Nuclear Physics Opportunities at Jefferson Lab

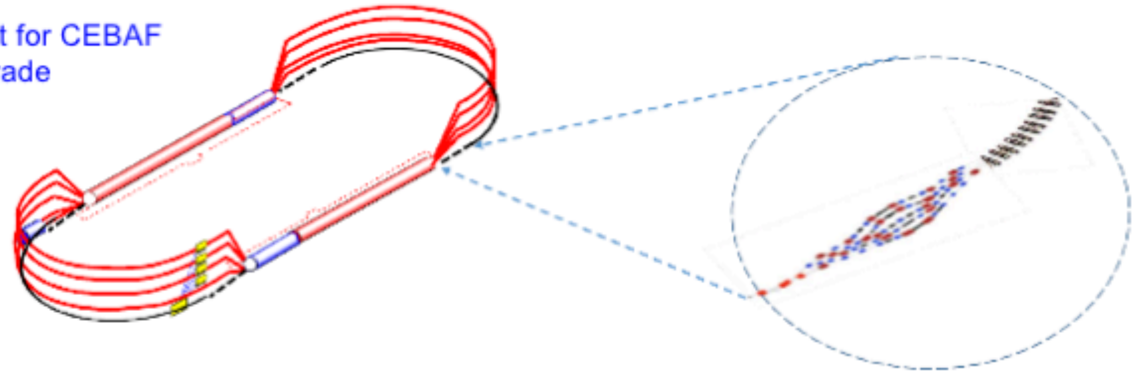
L. Harwood, G. Krafft, R. D. McKeown, W. Melnitchouk, S. Stepanyan
(Future Nuclear Physics Task Force)

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)

CLAS12 future upgrades

JLAB upgrades

Future Nuclea

L. Harwood, G. Krafft, R. D
(Future Nuclear Physics T
September, 2020
(Thanks to C. Keppel, A. Hut

- Higher luminosity/
- Positron beams in
- Modest CEBAF en nuclear femtograp
- Isotope production

FFA concept for CEI energy upgrade

White paper i
B. Mc

Physics opportunities: SIDIS/TMD

SIDIS @JLAB

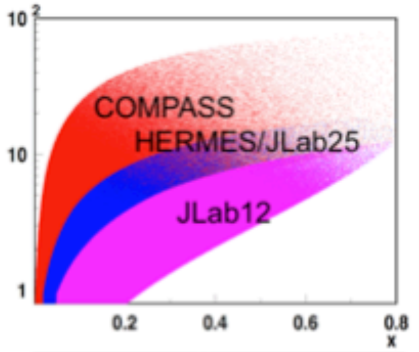
- JLab12: a leading provider of information on 3D nucleon structure
  - Dihadron production: qualitatively new opportunities to study the non-perturbative QCD
  - Understanding the hadronization process
- Measurement of multiplicities and spin azimuthal asymmetries for all combinations of beam and target polarizations to access underlying TMDs

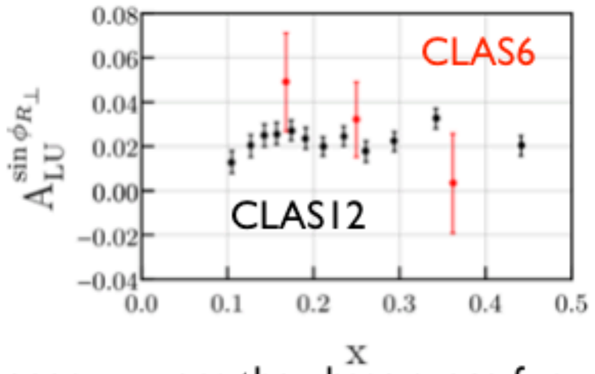
JLab 6 GeV to 12 GeV upgrade as an example

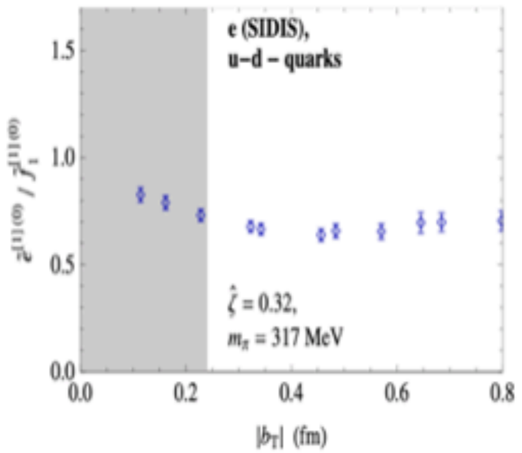
Observation of SSAs in $ep \rightarrow e'\pi^+\pi^- X$

T. Hayward et al. Phys. Rev. Lett. 126, 152501 (2021)

$$d\sigma_{LU} \propto \lambda_e \sin(\phi_{R_\perp}) \left(xe(x) H_1^{\sphericalangle}(z, M_h) + \frac{1}{z} f_1(x) \tilde{G}^{\sphericalangle}(z, M_h) \right)$$







Doubling the JLab beam energy, opens the phase space for SIDIS dihadrons

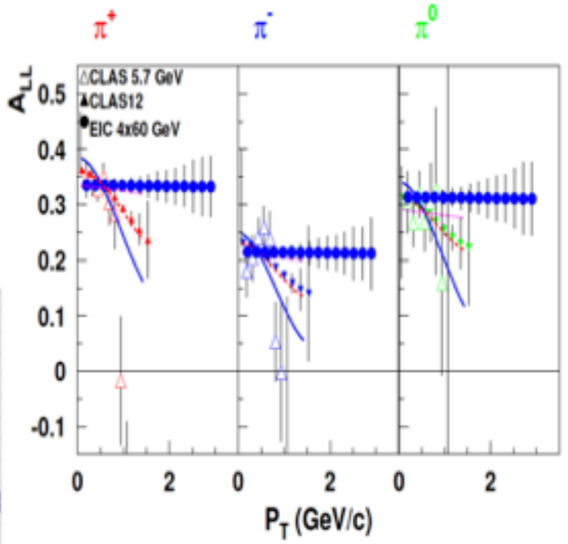
Quark gluon correlations may be very significant

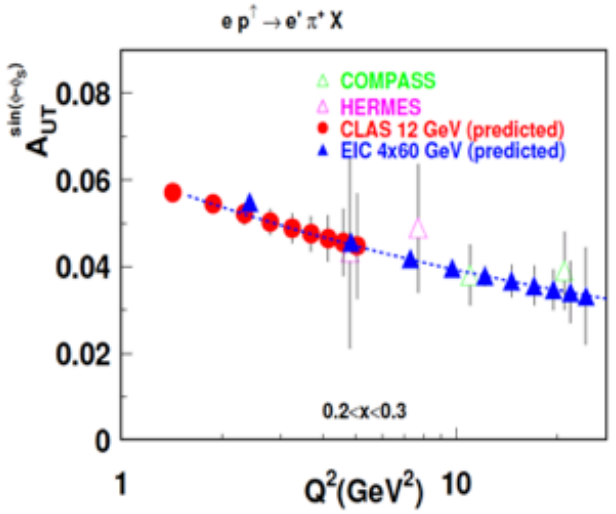
- Opportunities with 24 GeV
  - Enhancing the range in transverse momentum P_T of hadrons
  - Enhancing the Q^2 range
  - Enhancing the x-range

N/q	U	L	T
U	f_1		$h_1^\perp$
L		g_1	$h_{1L}^\perp$
T	$f_{1T}^\perp$	$g_{1T}^\perp$	h_1 $h_{1T}^\perp$

CLAS12 kinematical coverage

k_T-dependence $g_1(x, k_T)$ Q^2-dependence of Sivers $f_1^\perp(x, k_T)$





- Large acceptance of CLAS12 allows studies of P_T and Q^2-dependence of SSAs in a wide kinematic range (most critical for TMD studies)
- Comparison of JLab12 data with HERMES, COMPASS and EIC will pin down transverse momentum dependence and the non-trivial Q^2 evolution of TMD PDFs in general, and Sivers function in particular.

JLAB upgrades

Future Nuclea

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September, 2020

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White paper i
B. Mc

Physics opportunities: SIDIS/TMD

SIDIS @JLAB

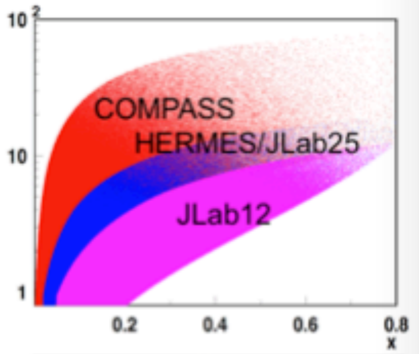
- JLab12: a leading prov
  - Dihadron production: perturbative QCD
  - Understanding the hadro
- Measurement of mult all combinations of underlying TMDs

JLab 6 GeV to 12 G

Observation of SSA

T. Hayward et al. Phys. Rev. Lett. 12

$d\sigma_{LU} \propto$

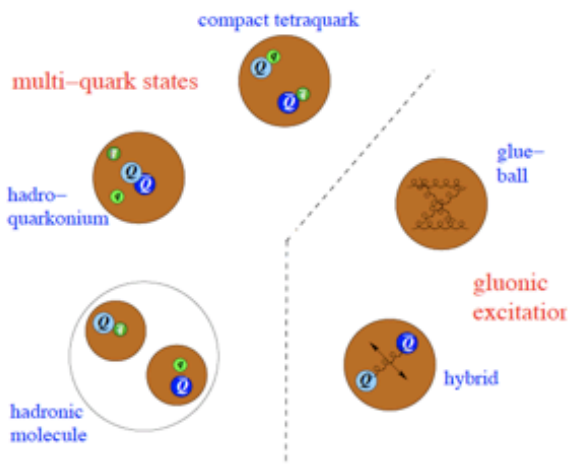


Doubling the JLab beam e
SIDIS
Quark gluon correlat

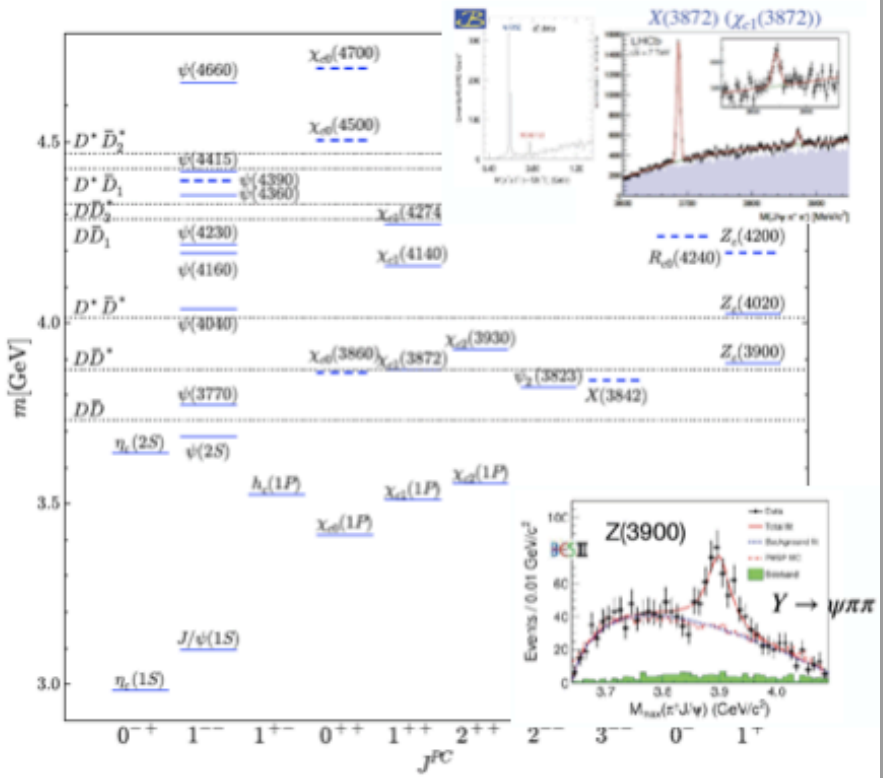
Physics opportunities: Meson Spectroscopy

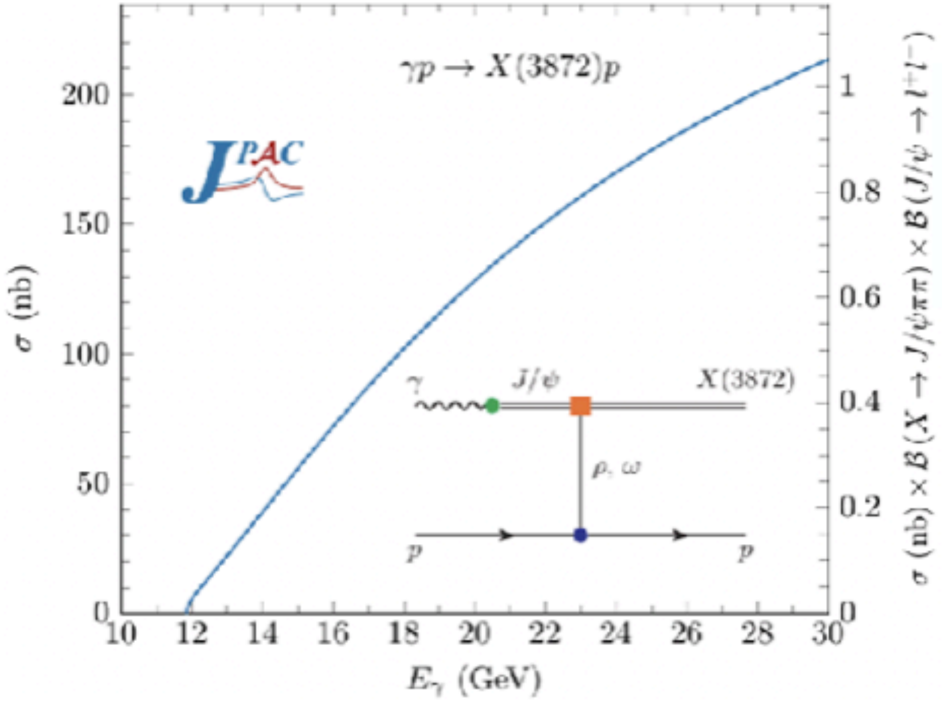
- Electro/photo production at 20 GeV ideal kinematics and rates
- 10^8 γ/s to produce ~100 events of rare sites (electroproduction more efficient at high energy
- XYZ's and Pq's an be directly produced from beam (meson) or target fragmentation (wrt indirect at LHCb/BES-III/BELLE)
- Pentaquark search
- Polarization observables

- Multi-quarks configurations



- Exotic charm spectroscopy (XYZ states)





$\mathscr{L} \sim 500pb^{-1}/yr$ (at $E_\gamma = 20GeV$) with 1% eff.

Number of events = $\sigma\mathscr{B}(X \to J/\psi\pi\pi)\mathscr{B}(J/\psi \to l^+l^-)$

~3000 events/yr

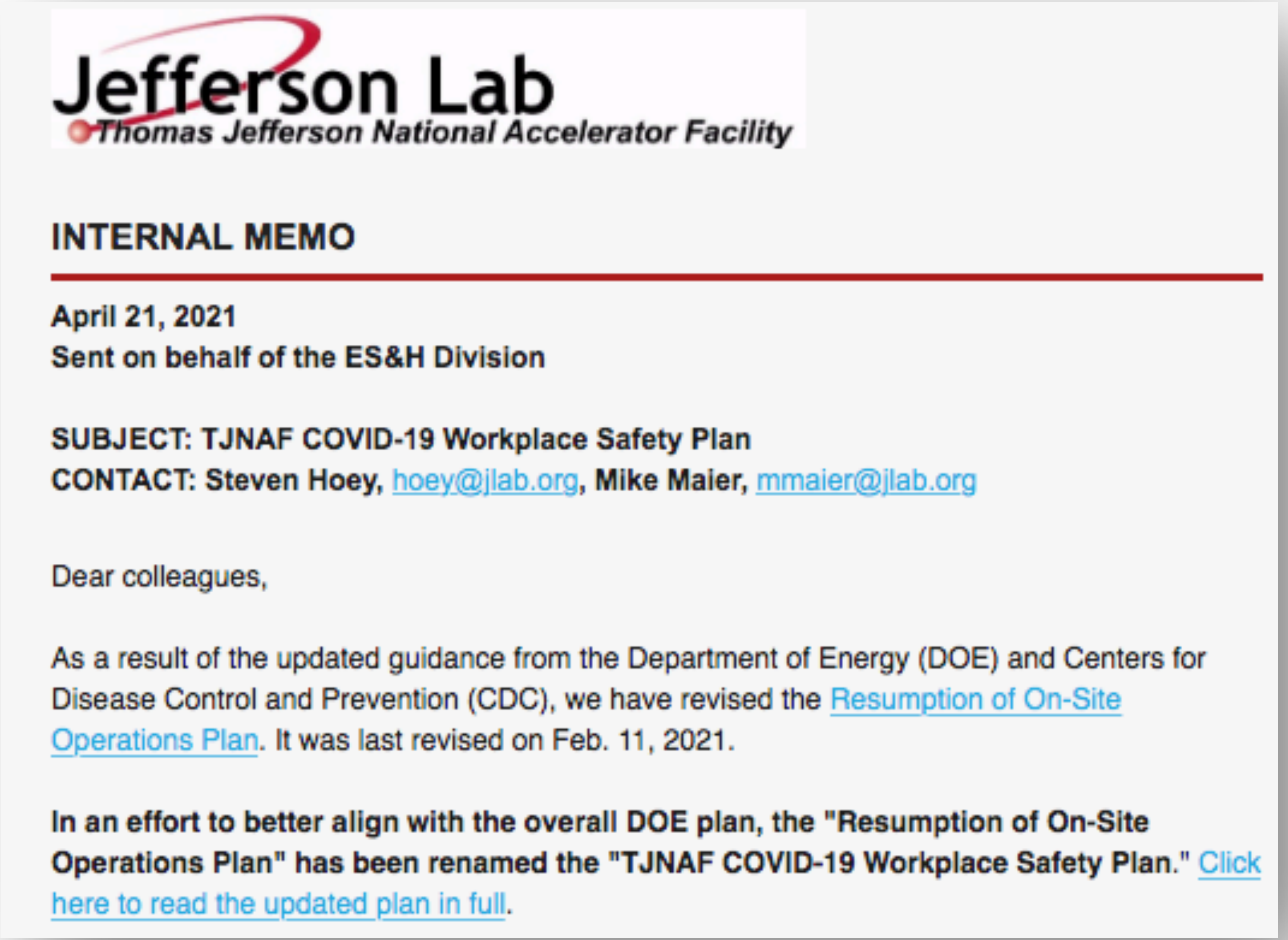
- Projections:
  - X(3872) ~100nb Y~3000 ev/y
  - Y(4220) ~5nb Y~50 ev/y
  - Z(3900) ~10nb Y~1000 ev/y

BESIII
- X(3872): about 20 events with 3000 pb^{-1} (2013)
- Y(4260): about 6k events with 3000 pb^{-1} (2016)
- Z(3900): about 300 events with 525 pb^{-1} (2013) about 1200 events with 1900 pb^{-1} (2017)

JLab, E_γ = 20 GeV, 500 pb^{-1} assuming 1% acceptance/efficiency
- X(3872): 3000 events
- Y(4260): 50 events
- Z(3900): 1000 events

Summary

- The COVID-19 related emergency remains in place but the lab is preparing for resumption of On-site operations, including: travel policy, face masking, capacity restrictions, vaccination , …
- FY21: SAD is progressing with the scheduled maintenance, so far no delay expected to the official physics beam date (Aug 20, 2021)
- Preparing to run HPS and RG-M in CY 2021 and RG-C in 2022
- Preparing remote shift policy (in case travels will not be possible)
- CLAS12 RICH-II module assembly is progressing
- Support to ALERT RG to conclude the ERR
- Data preparation: significant effort supported by Hall-B SW group and CALCOM to conclude PassI on the whole CLAS12 data and prepare for Pass2
- Data Analysis: first CLAS12 PRL (!), the second under review and many in preparation


Jefferson Lab
Thomas Jefferson National Accelerator Facility

INTERNAL MEMO

April 21, 2021
Sent on behalf of the ES&H Division

SUBJECT: TJNAF COVID-19 Workplace Safety Plan
CONTACT: Steven Hoey, hoey@jlab.org, Mike Maier, mmaier@jlab.org

Dear colleagues,

As a result of the updated guidance from the Department of Energy (DOE) and Centers for Disease Control and Prevention (CDC), we have revised the Resumption of On-Site Operations Plan. It was last revised on Feb. 11, 2021.

In an effort to better align with the overall DOE plan, the "Resumption of On-Site Operations Plan" has been renamed the "TJNAF COVID-19 Workplace Safety Plan." Click here to read the updated plan in full.

- In preparation for PAC49: two new proposal and a LoI
- On a longer range, preparing the future experiments (RG-H and other RGs) and the HI-LUMI operations of the CLAS12 detector