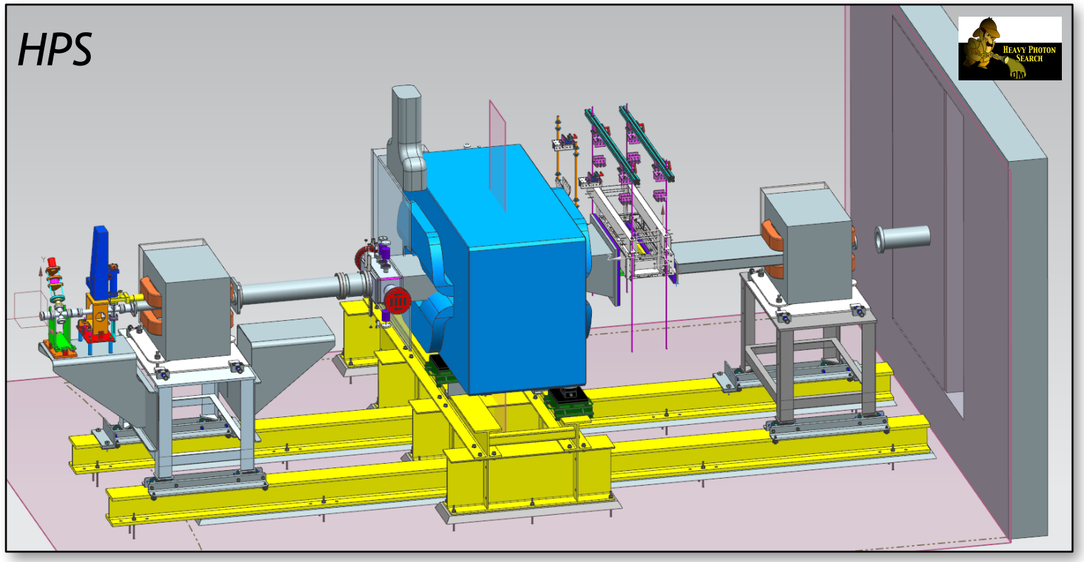
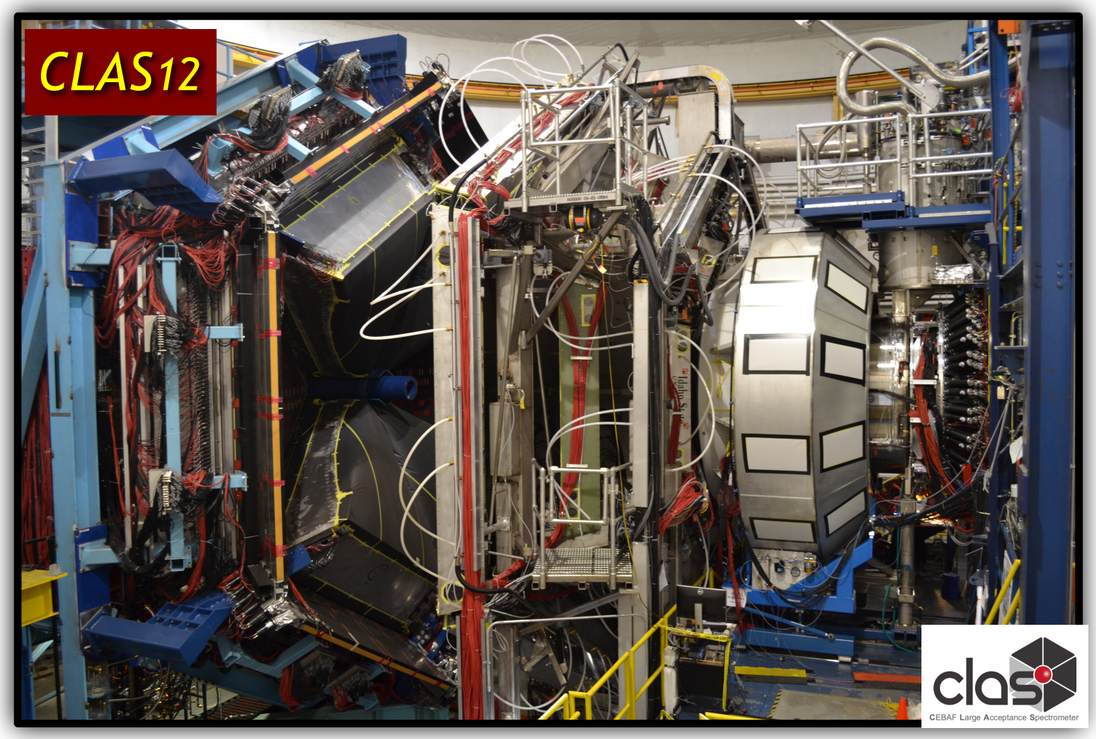
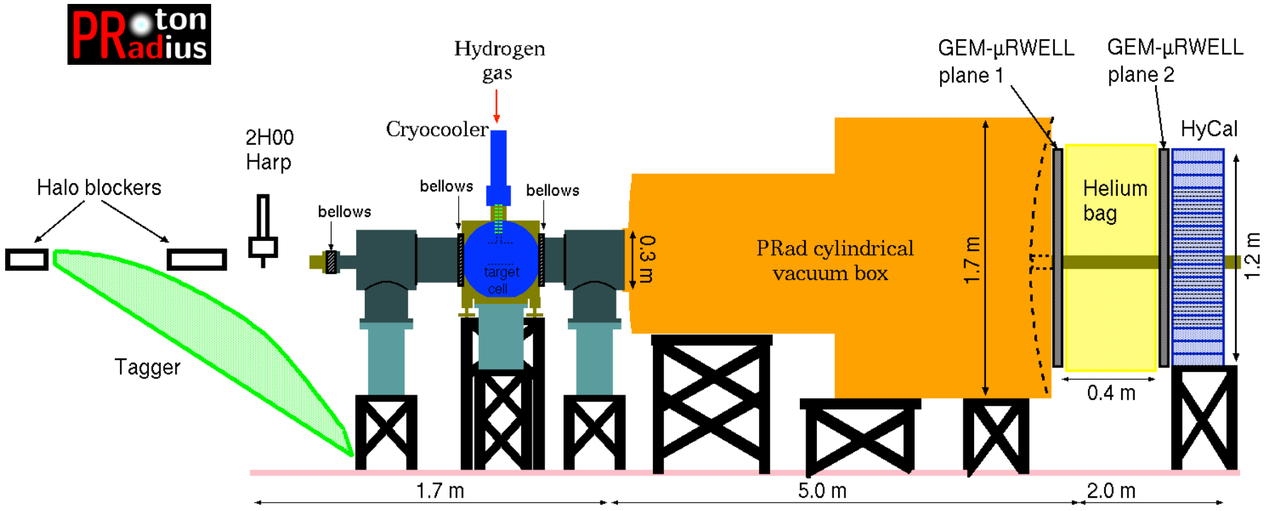






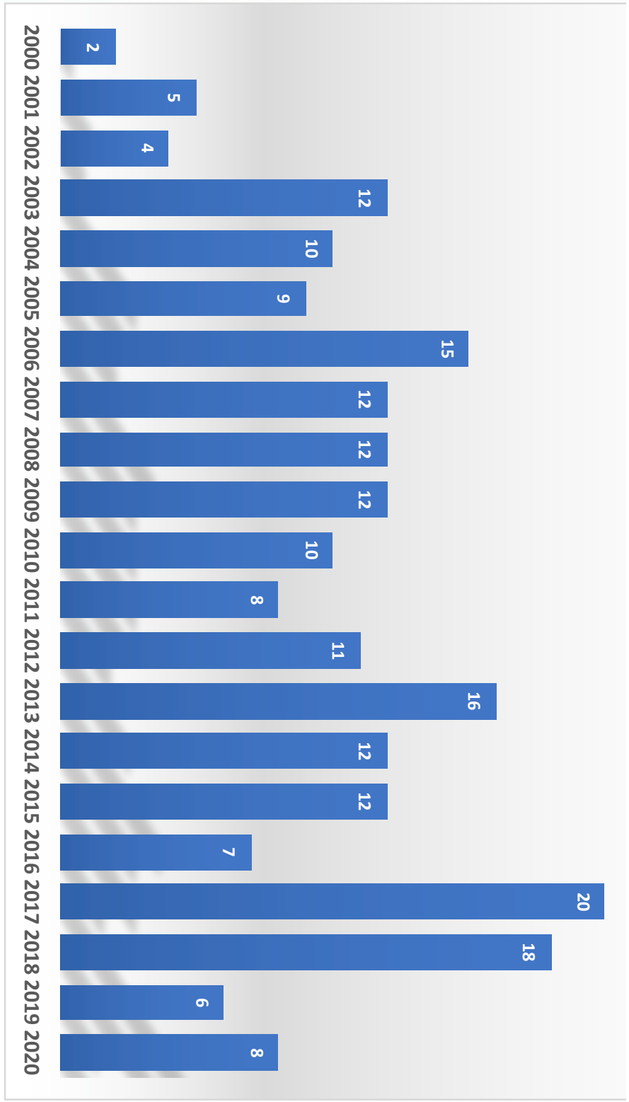
CLAS Collaboration Meeting
Nov 10-13, 2020

Status of Hall B

Marco Battaglieri
Jefferson Lab

Refereed Physics Publications Hall B

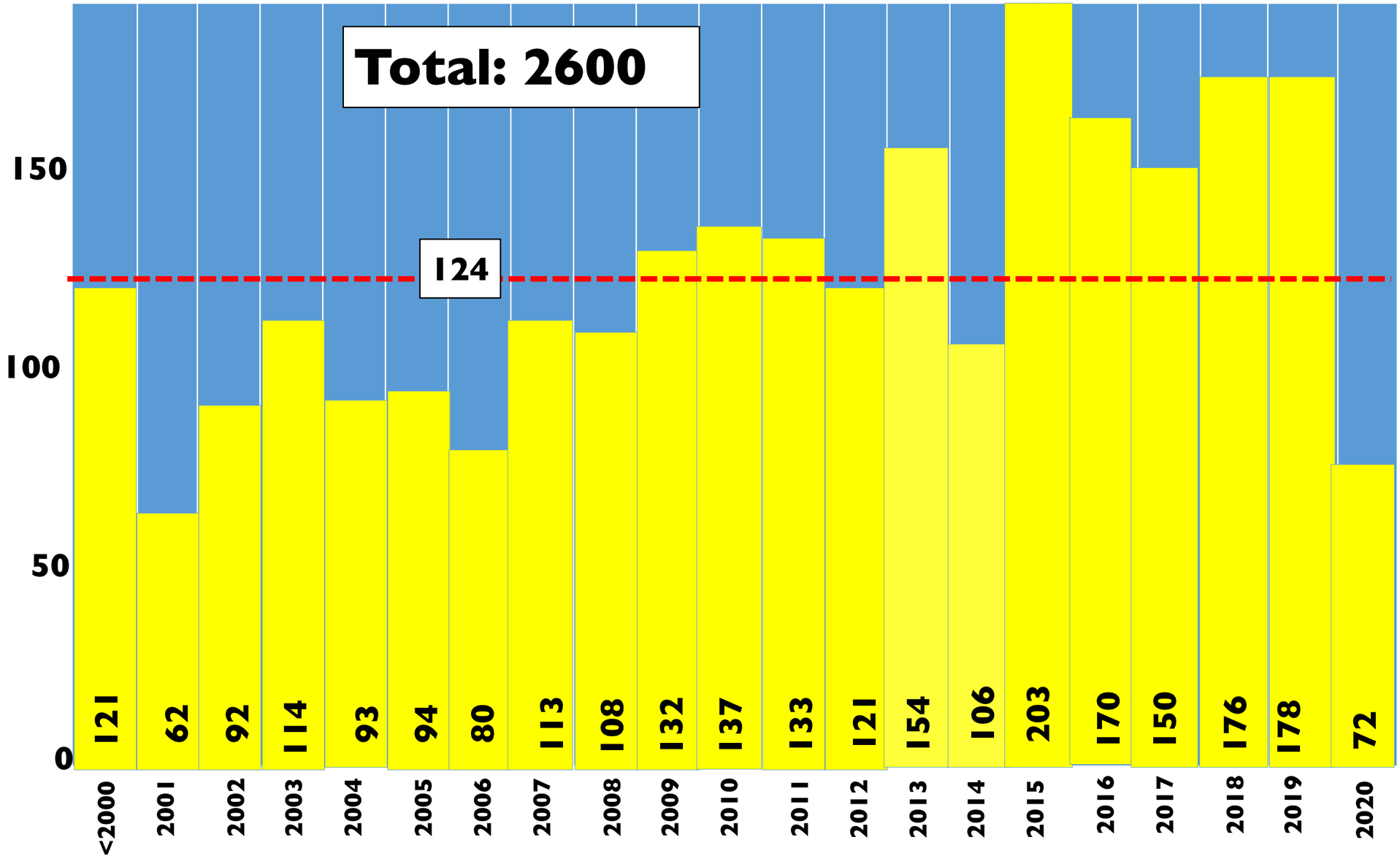
	Spectroscopy	Hard Scattering	Nuclear	ALL
2000		1	1	2
2001	2	3		5
2002	3		1	4
2003	7	4	1	12
2004	3	3	4	10
2005	7	3	2	9
2006	8	4	3	15
2007	7	2	3	12
2008	4	6	2	12
2009	8	7	4	12
2010	4	2	4	10
2011	3	1	4	8
2012	6	3	2	11
2013	8	6	2	16
2014	5	6	1	12
2015	4	5	3	12
2016	7			7
2017	12	7	1	20
2018	10	6	2	18
2019	1	2	3	6
2020	5	1	2	8
SUM	114	62	45	221



+ 1 CLAS paper submitted to Nature
+ 5 CLAS papers under internal review
+ 2 CLAS12 papers under internal review

updated 11/09/2020

Conference Presentations

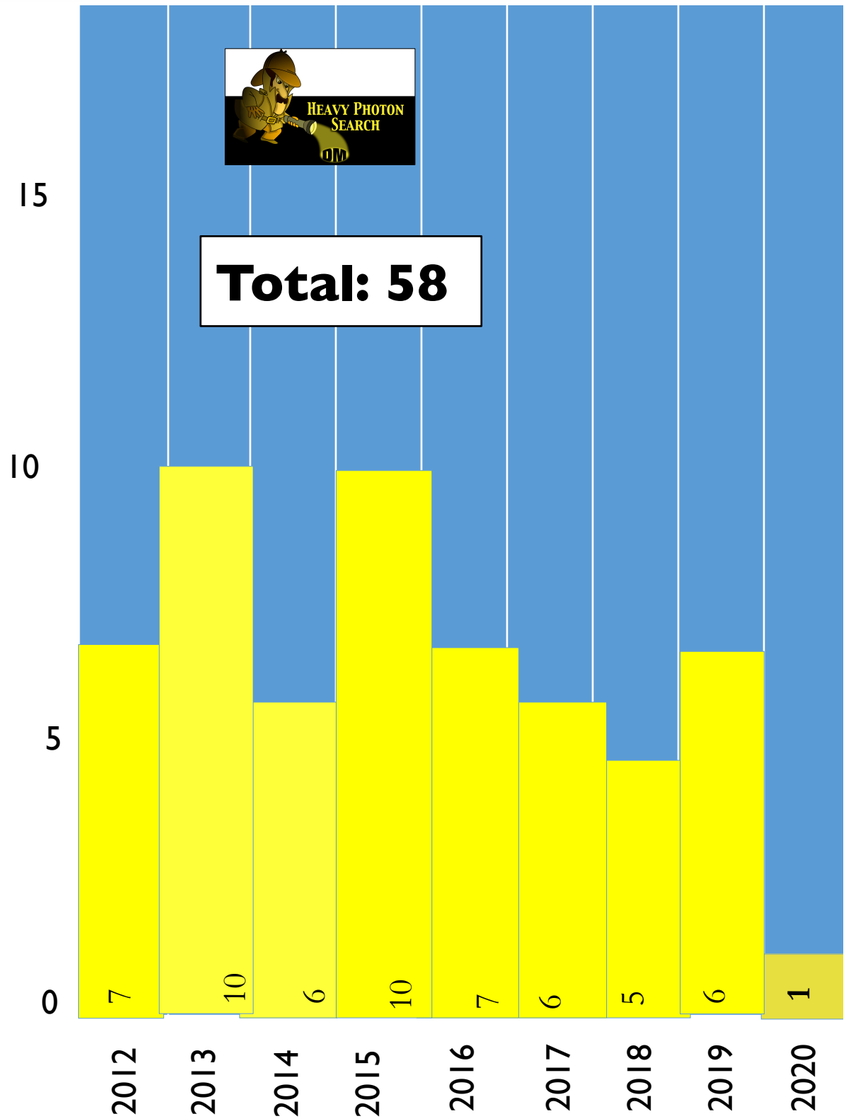


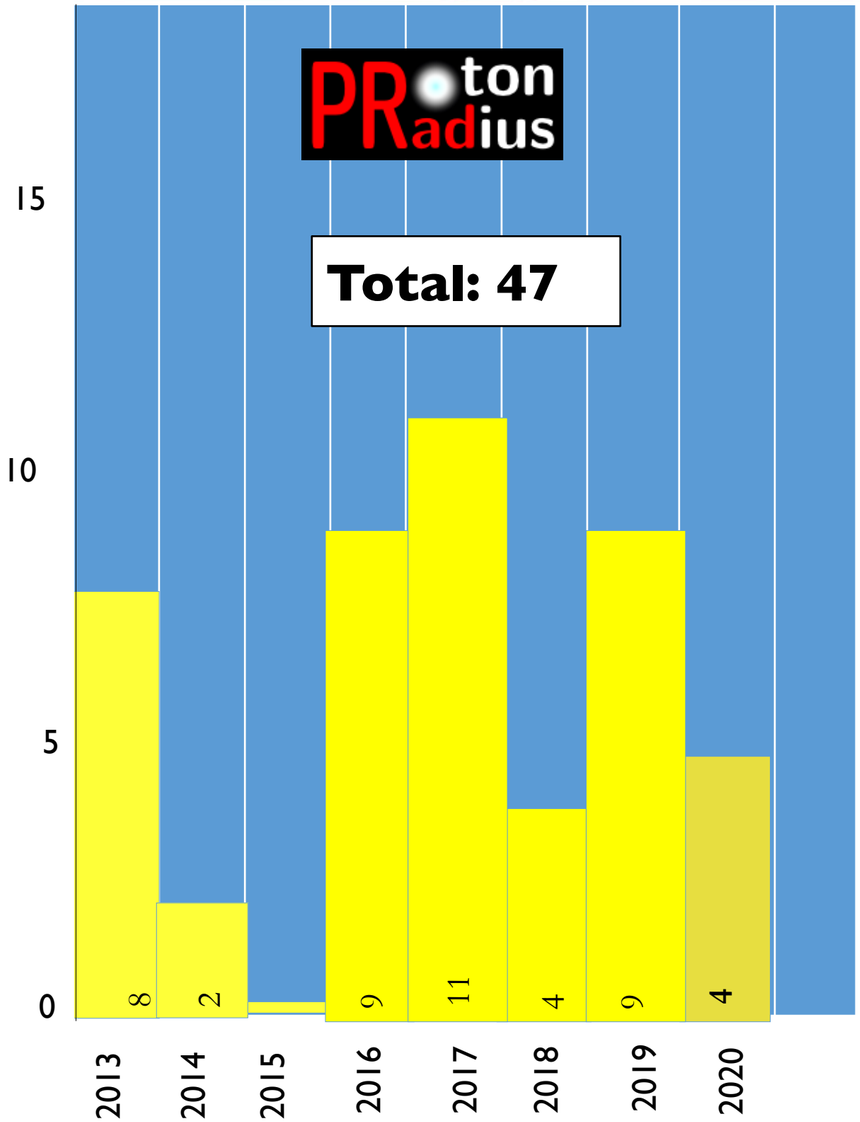
Source: CSC

updated Nov 9 2020

Conference Presentations

Hall B





Source: HPS & PRAD wiki

updated Nov 9 2020

Hall B highlights

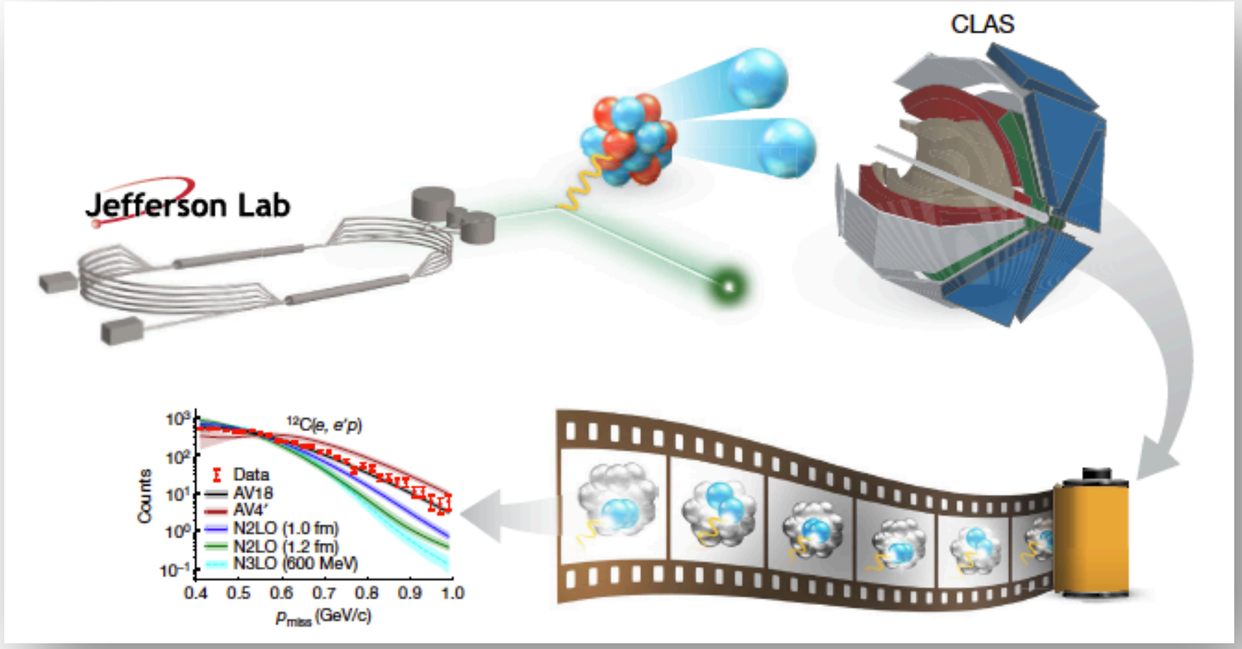
- **CLAS12 physics runs:**
  - RG-A (13 proposals,139 PAC days)
  - RG-K (3 proposals, 100 PAC days)
  - RG-B (7 proposals, 90 PAC days)
  - ✓ RG-F (BONUS, 42 PAC days)

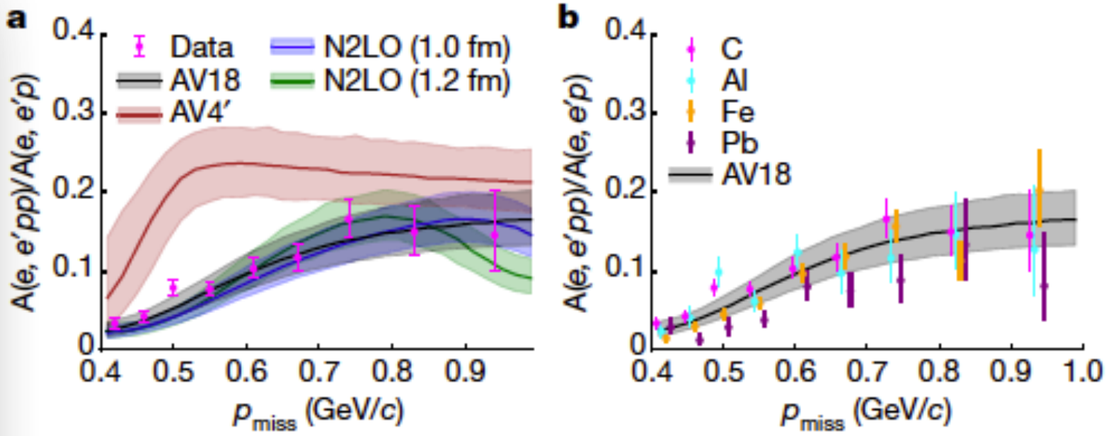
- **Continued flow of results from Hall B (CLAS+PRAD+HPS+PRIMEX..)**
  - > 230 physics papers in peer reviewed journals (> 14,000 citations)
  - 5 papers in **Nature**, 1 paper in **Science** (+ one submitted)
  - ~2,600 conference talks (~1,650 invited)

- **Specialized Hall B experiments**
  - PRAD experiment – results published in **Nature**
  - PRIMEX - results published in **Science**
  - Heavy Photon Search -Calibrations of 2019 data ongoing

Nuclear interaction via e-scattering

Hall B





- CLAS6 data mining activity
- Electron-nucleus scattering to test nuclear interaction
- Short range correlations up to 400 MeV/c (relative p)
- Transition from spin-dependent tensor force to spin-independent scalar force
- Access to nuclear force in extreme conditions (neutron stars)

Nature **volume 578**, pages 540-544 (2020)

Article

Probing the core of the strong nuclear interaction

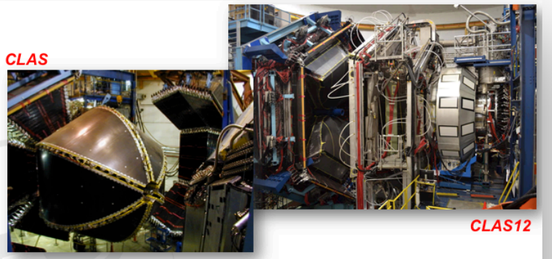
https://doi.org/10.1038/s41586-020-021-6
Received: 21 August 2019
Accepted: 10 January 2020
Published online: 26 February 2020
Check for updates

A. Schmidt[1,2], J. R. Pybus[1], R. Weiss[3], E. P. Segarra[1], A. Hrnjic[1], A. Denniston[1], O. Hen[1]✉, E. Piasetzky[4], L. B. Weinstein[5], N. Barnea[3], M. Strikman[6], A. Larionov[7], D. Higinbotham[8] & The CLAS Collaboration*

The strong nuclear interaction between nucleons (protons and neutrons) is the effective force that holds the atomic nucleus together. This force stems from fundamental interactions between quarks and gluons (the constituents of nucleons)

CLAS12 preliminary results @ DNP

Hall B

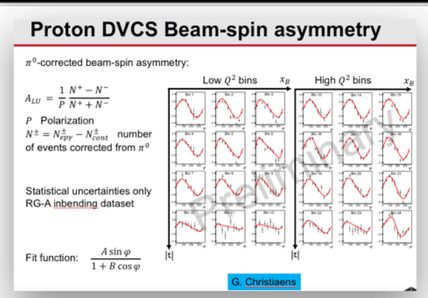


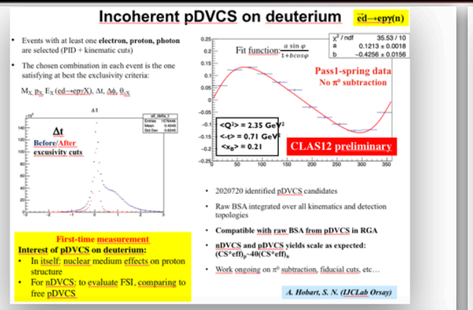
CLAS Collaboration Presentations

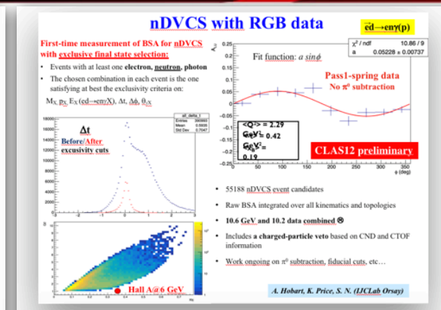
Latifa Elouadrhiri
for the CLAS Collaboration

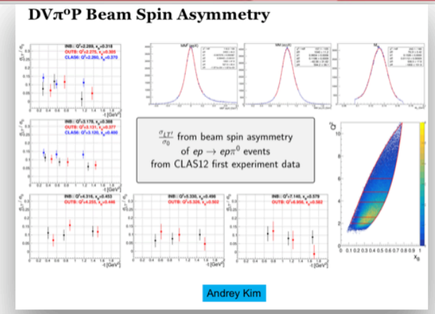
Hall- B TF Meeting Sunday, October 25, 2020

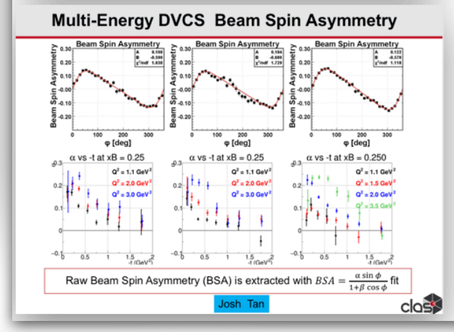
clas

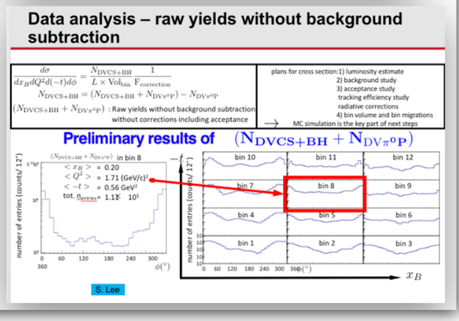


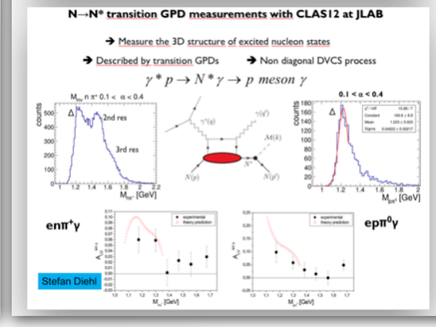


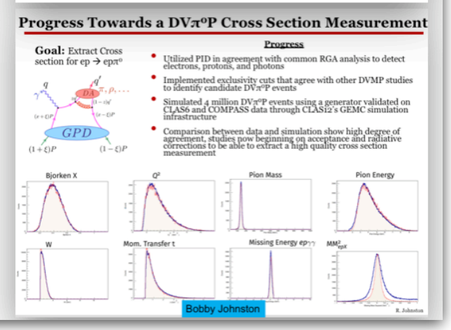












Mini-Symposium: Electromagnetic Form Factors of N*'s, Sessions DQ, EQ, and FQ, October 30, 2020

Goals: Facilitate joint efforts between experiment, phenomenology and theory on exploration of the spectrum and structure of the ground and excited states of the nucleons from the CLAS and CLAS12 data in order to get insight into strong interaction dynamics which underlie the baryon generation from quarks and gluons.

Organizers: **K. Hicks**, Ohio U., **V.I. Mokeev**, Jefferson Lab

Invited review talks:
1. Studies of Excited Nucleon Structure with CLAS and CLAS12
   Prof. K. Joo, University of Connecticut, USA
2. Ground and excited nucleon structure within continuum QCD approaches
   Prof. J. Segovia, Pablo de Olavide University, Seville, Spain

Novel direction:
1. Exploring the Emergence of Deformation Dominance in Nuclear Structure from Strong QCD
   Prof. J.P. Draayer, Louisiana State University, USA

and 18 contributed talks

The CLAS/CLAS12 experiments were designed to perform complementary measurements with different beam energies different targets and different combination of polarizations to study:

- protons and neutrons structure for both the ground and excited states, 3D imaging and mechanical structure of the nucleon with the core mission to understand the manner in which the constituents of protons are held together by the strong force and the emergence of the dominant part of hadron mass.

- quark confinement and the role of the glue in meson and baryon spectroscopy

- strong interaction in nuclei – evolution of quark hadronization, nuclear transparency of hadrons

… and many more:

- SIDID single pi+ BSA (S.Diehl)
- Di-hadron SIDIS (T.Hayward)
- SIDIS pion multiplicity (G.Angelini)
- BAND physics program (C.Fogler)
- BSA in resonance region (V.Klimenko, E.Isupov)
- Resonance electrocoupling (K.Neupane)
- Incluse cross section (N.Markov)
- RG-F (BONUS) report E.Christy)

Credit:L.Elouadrhiri

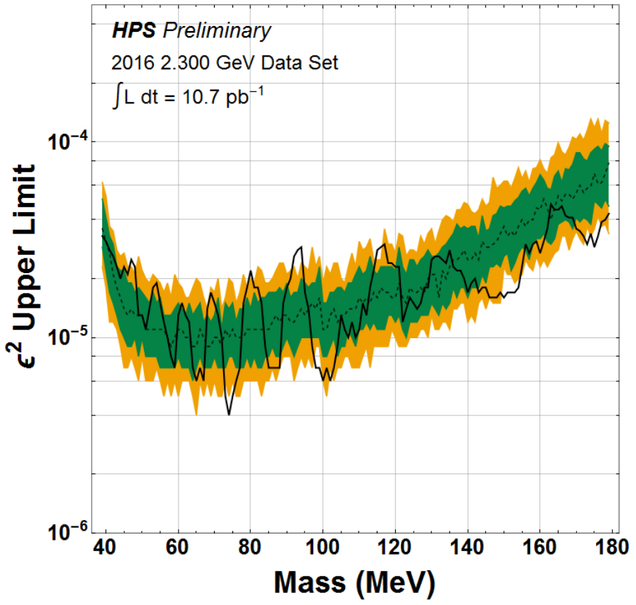
Heavy Photon Search

Hall B

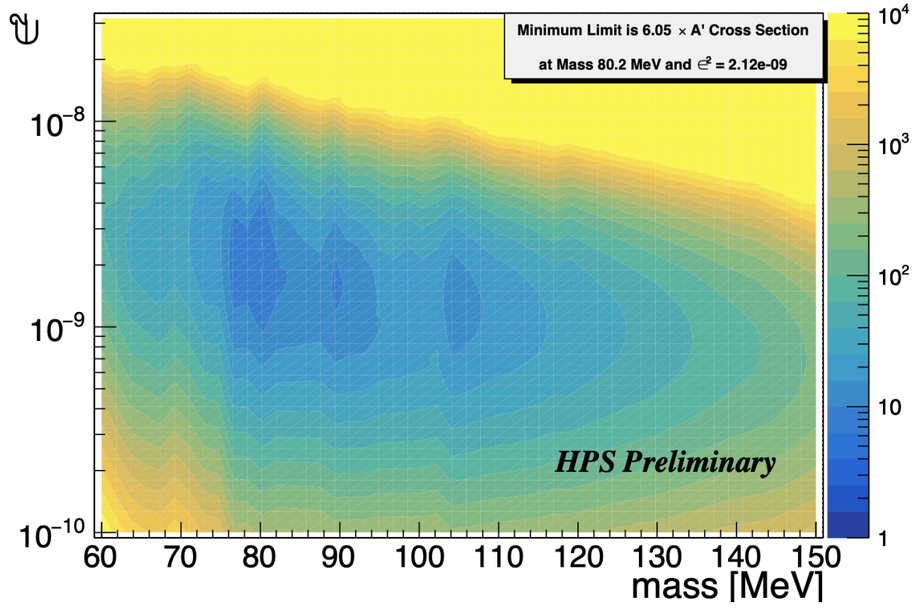
- HPS successfully defended remaining beamtime at the PAC48 jeopardy hearing. The PAC endorsed the HPS run plan and recommended maintaining the remaining time allocation (135 days) as well as the experiment grade A
- The review of the resonance search analysis completed, started drafting the paper. The second stage of the displaced vertex analysis is in progress.

- Continue calibration of 2019 data and preparations for 2021 run .
- Updates will be presented at the collaboration meeting, November18-20 https://www.jlab.org/conference/HPS_NOV2020

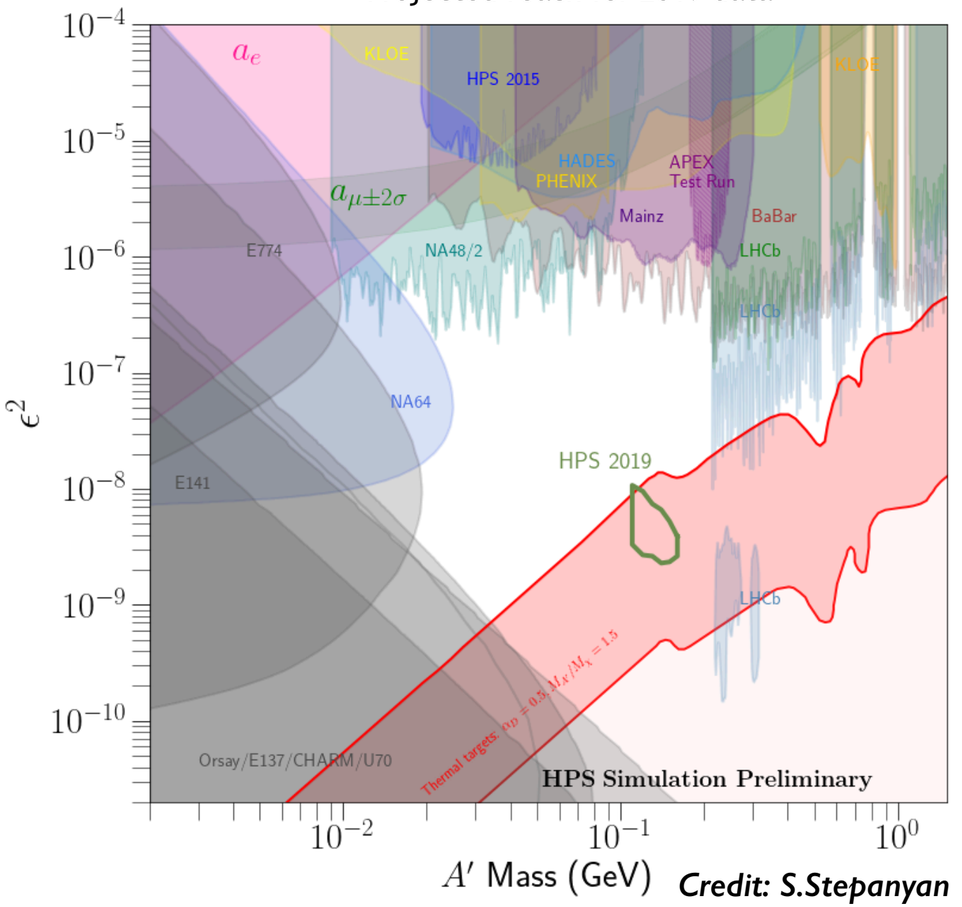
Resonance search method



Displaced vertex analysis, OIM



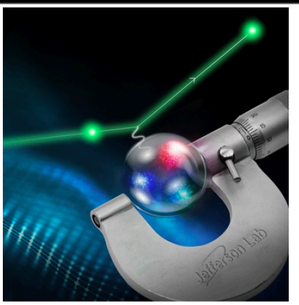
Projected reach for 2019 data



Credit: S.Stepanyan

Proton Charge Radius

Hall B



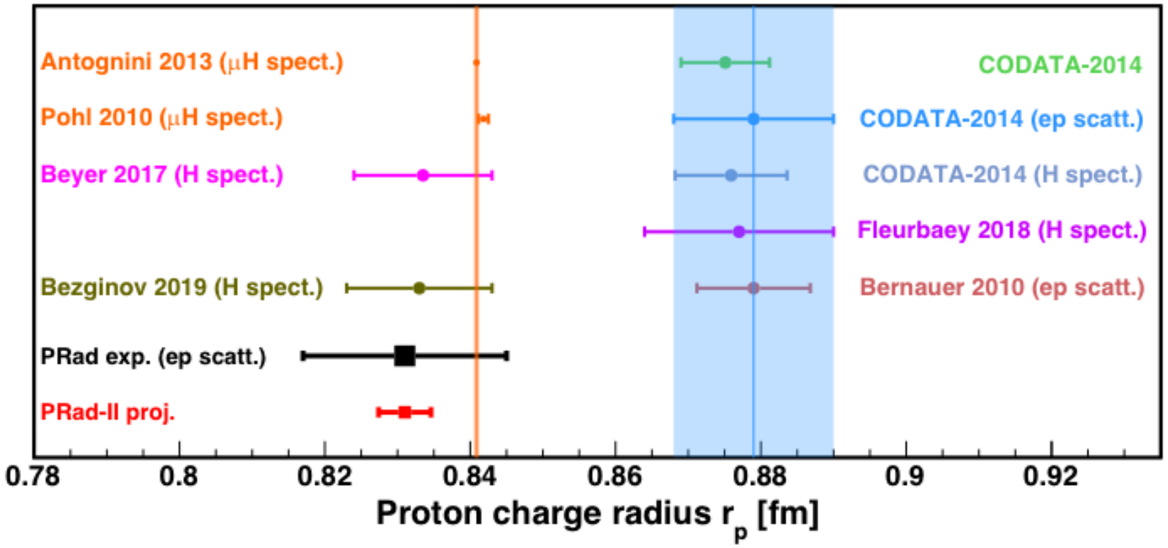
Two new proposal for PAC48

- PRad-II: a new and upgraded version of PRad-I. Awarded by PAC48 with A grade (40 PAC days)
- DRad: deuteron charge radius from elastic electron-deuteron scattering (Deferred by PAC48)

PRad-II preparation

- Adding tracking capability (second plane of GEM/μRwell detectors)
  - (a) preparing a μRwell prototype detector for summer beam tests
  - (b) preparing full funding proposal for GEM (or μRwell detectors)
- Small-size scintillator detectors just downstream the target to veto Moller electrons to reach the 10^{-5} GeV^2 Q^2 range
  - work in progress with JLab Target Group to finalize the pre-engineering drawings
- Adding new 'beam halo blacker" just before the Tagger
  - could be a copy of the existing "collimator" downstream the Tagger.
  - work needed for engineering drawings, manufacturing and construction.
- HyCal upgrade to all $PbWO_4$ crystals, essential for ep-inelastic background suppression at relatively higher Q^2 range (10^{-2} GeV^2) and uniformity over full acceptance
  - needs 2,300 new crystal detectors. Currently working on two directions:
    - (a) looking for used crystal detectors from other experiments (PANDA, CMS, …)
    - (b) include it ($4.0 M) in full funding proposal, in prep. (as NSF Mid-scale RI-1, …)
- DAQ/electronics upgrade to fADC based electronics:
  - (a) borrow from Jlab/Hall B
  - (b) include it ($3.2 M) in the full funding proposal, in preparation

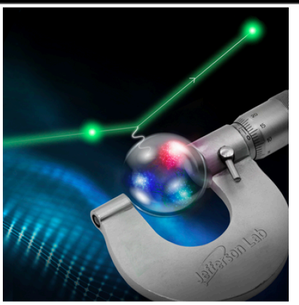
Collecting sizeable more statistics with an upgraded detector
PRad-II expects 3.8 times improvement in total uncertainty
$\delta R_p = \pm 0.43\%$



Credit: A.Gasparyan

Proton Charge Radius

Hall B



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Collecting sizeable more statistics with an upgraded detector

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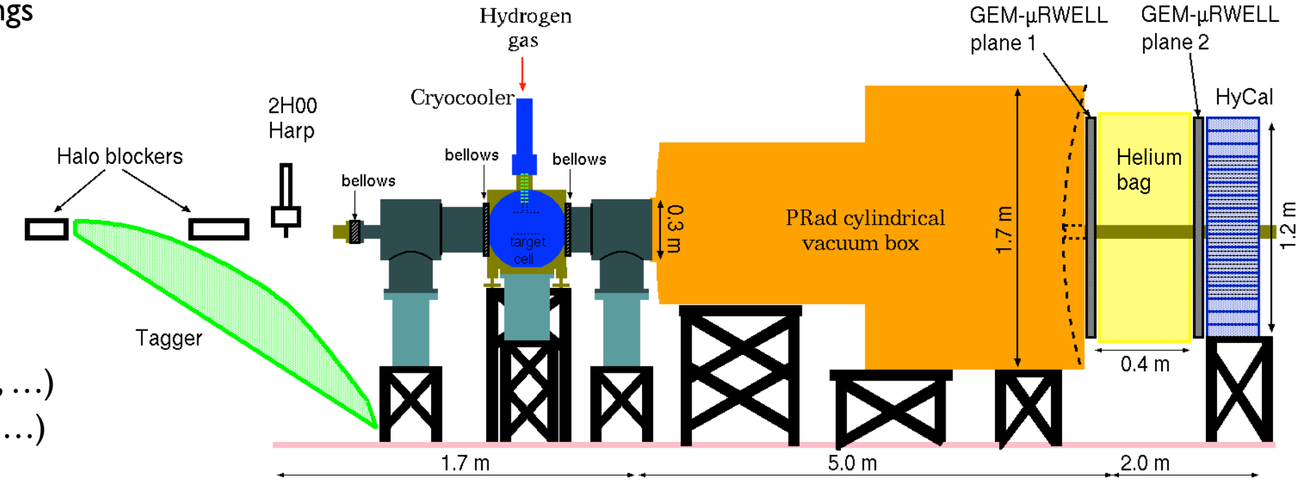
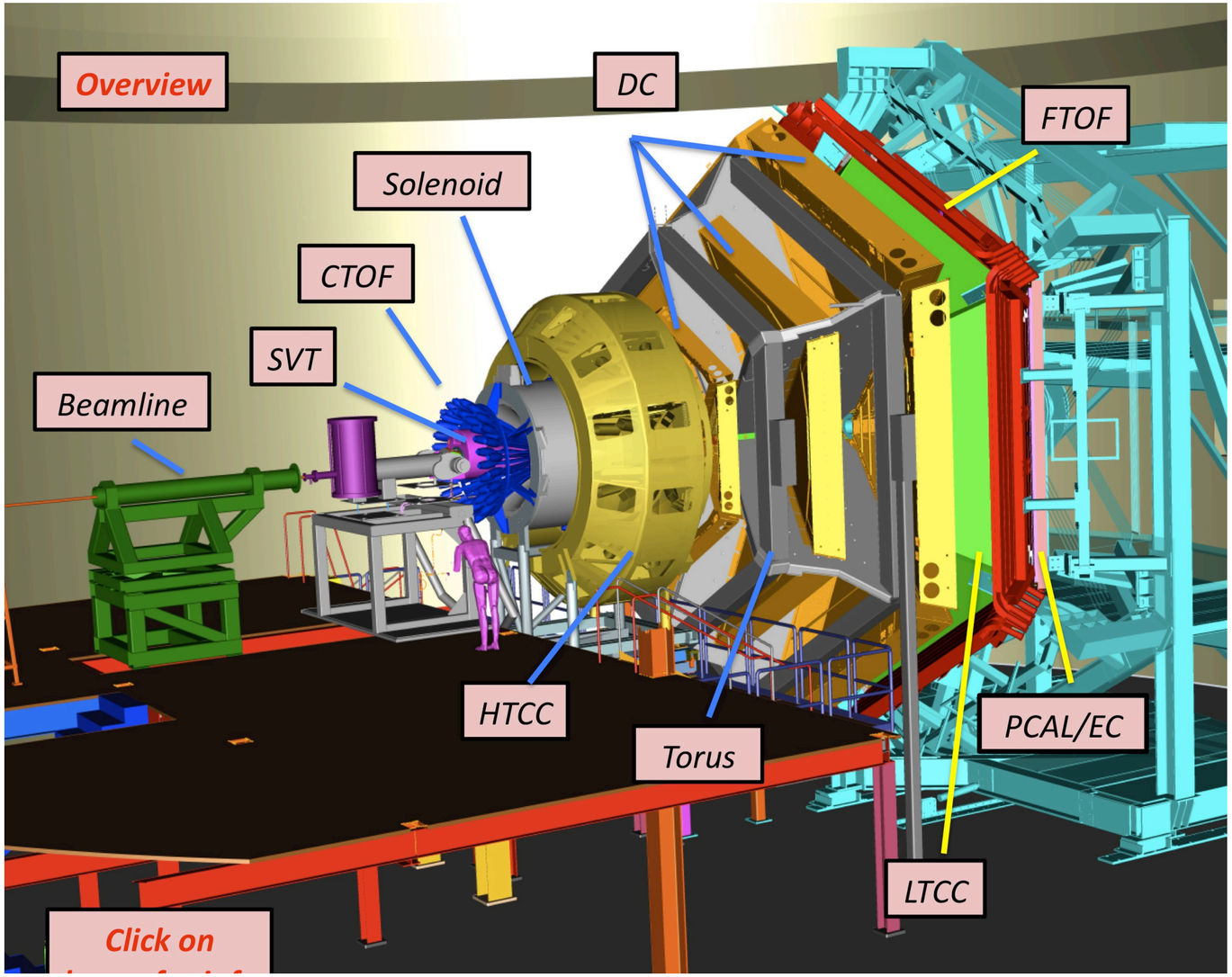
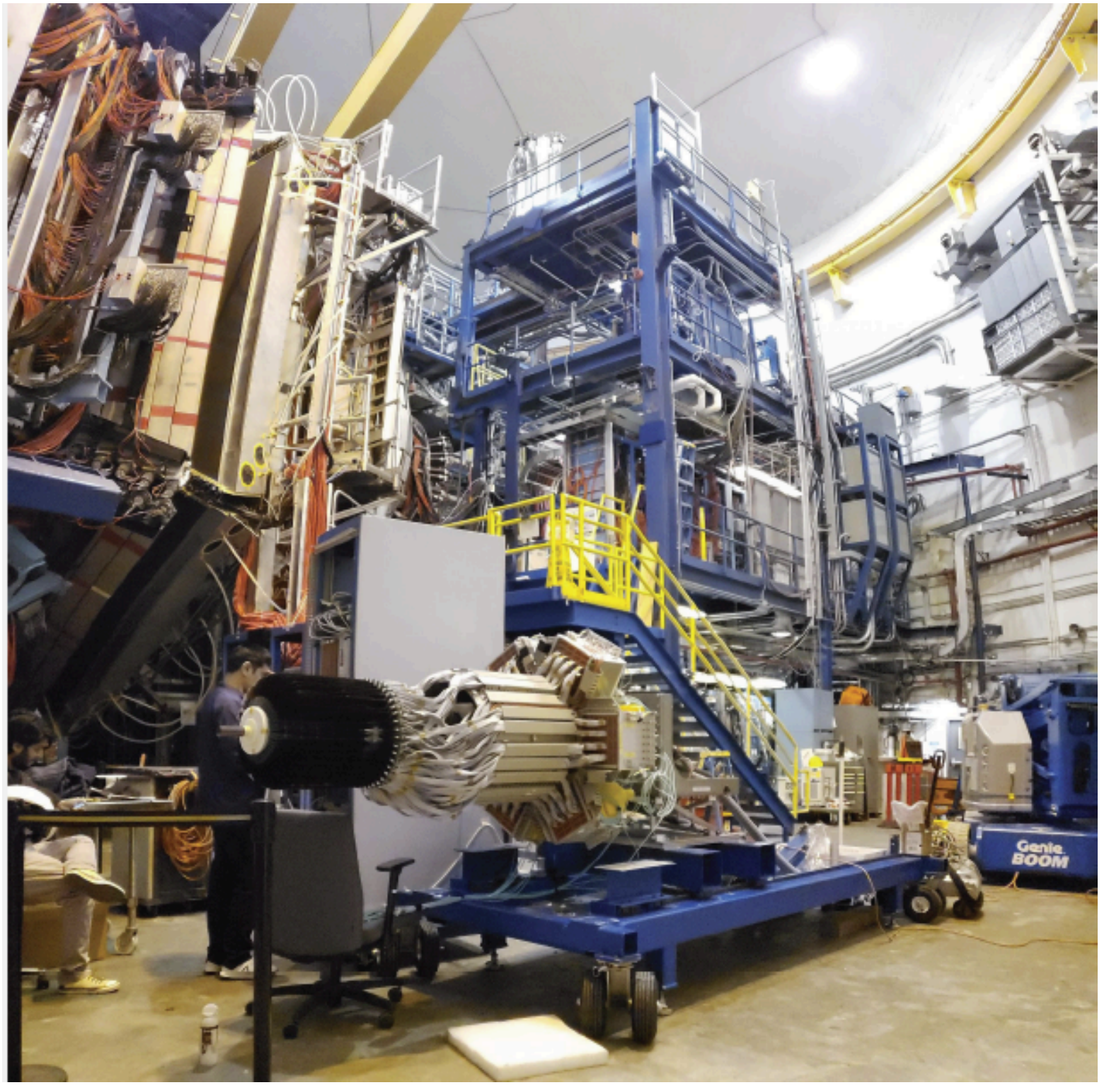
$\delta R_p = \pm 0.43\%$



Credit: A.Gasparyan


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


Genie
BOOM

Data Taking

- **Run Group A**:
  - 13 experiments
  - 10.2-10.6 GeV polarized electrons
  - Liquid-hydrogen target
  - ~300 mC, ~50% of approved beam time

- **Run Group K**:
  - 3 experiments
  - 6.5, 7.5 GeV polarized electrons
  - Liquid-hydrogen target
  - ~45 mC, ~12% of approved beam time

- **Run Group B**:
  - 7 experiments
  - 10.2-10.5 GeV polarized electrons
  - Liquid-deuterium target
  - ~155 mC, ~43% of approved beam time

- **Run Group F (BONUS)**:
  - 7 experiments
  - 10.2 GeV polarized electrons (+2.2 GeV for calibration)
  - Gas-deuterium target +RTPC
  - ~92% of approved beam time (Run concluded!)

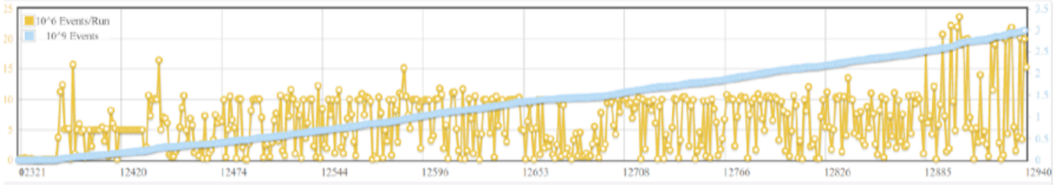
CLAS12 data taking

- from Feb 2017 (KPP) to Summer 2020 (physics runs)

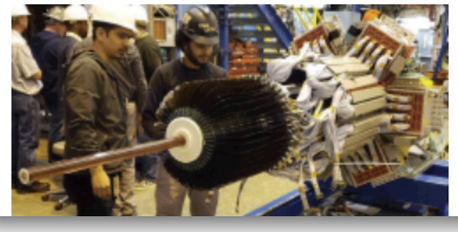
- **Nuclear targets test (special run)**:
  - 10.2 GeV electrons
  - LD2, LHe and Pb targets
  - 100% of scheduled time

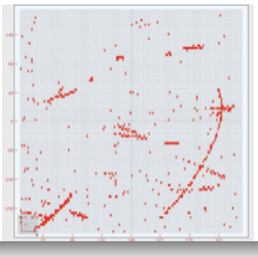
Hall-B operations

- Monday Sept 21st ended the RG-F physics run
- Generous effort of JLab staff members and local insts (ODU, HU, CNU, RichmndU) to cover shifts for a successful ru
- Good feedback by virtual shifts, plans to adopt them on regular base in the future
- Collected 77% of data in the II part of the run (+50% in the Ist) for a total of 92% of allocated RG-F PAC days



- Beside production runs on D2, regular calibration runs on different targets (empty, H2, He4) + Moeller measurement + dedicated run at low energy at the beginning of the run
- Dedicated equipment (BONUS RTPC)
- Decommissioning started, RTPC to EEL building (?), will be stored at ODU/HU





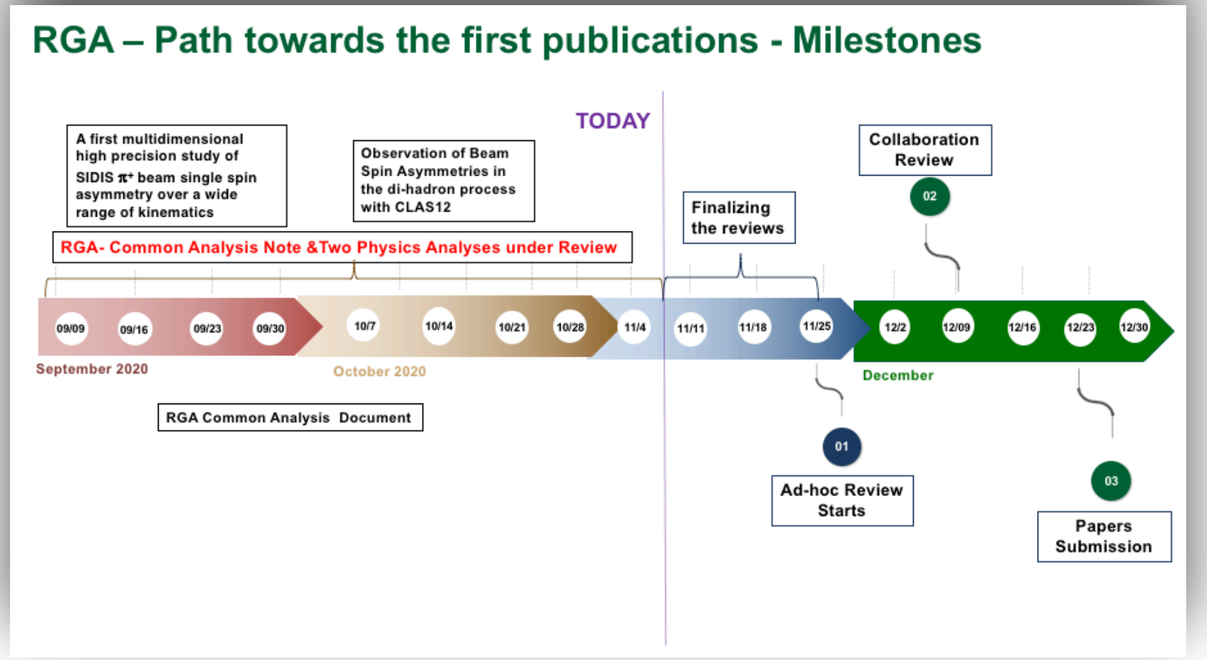
Data processing

	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	37% done	Restart cooking at the end of November
– **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	In progress	40% cooked	Restart cooking now
– **Run Group F (BONUS)**: • 7 experiments • 10.2 GeV polarized electrons (+2.2 GeV for calibration) • Gas-deuterium target +RTPC • ~92% of approved beam time	In progress	-	Start cooking in as soon as calibrations are ready

Pass2 preparation in progress

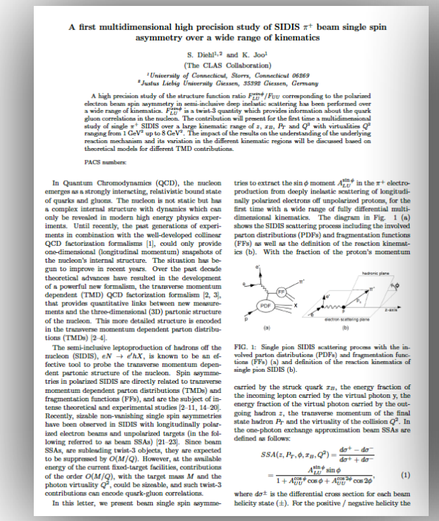
Toward the first CLAS12 publication (and beyond …)

- Initial focus on Transverse Momentum Distribution (TMDs) by SIDID
- Single hadron (S.Diehl) and di-hadron (C.Dilks) analyses well advanced
- After the DNP many analysis are ready for the publication stage (documentation, draft, review …)

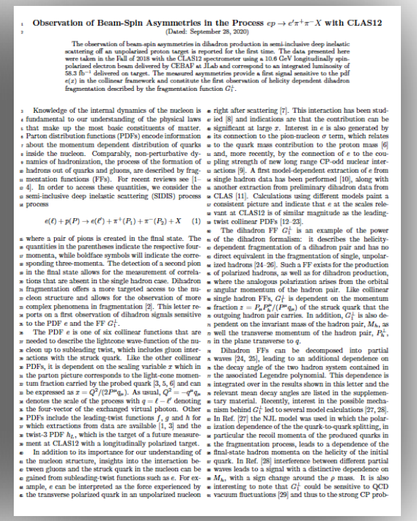


CLAS12 first publication status

- Two PRLs draft ready
- RGA general Analysis note ready and under review
- 2 analysis-specific note under review
- Next step: CLAS Coll. wide review and submission to the journal!


A first multidimensional high precision study of SIDIS π^+ beam single spin asymmetry over a wide range of kinematics

S. Diehl[1,2] and K. Joo[1]
(The CLAS Collaboration)
[1]University of Connecticut, Storrs, Connecticut 06269
[2]Justus Liebig University Giessen, 35392 Giessen, Germany


Observation of Beam-Spin Asymmetries in the Process $ep \to e'\pi^+\pi^- X$ with CLAS12
(Dated: September 28, 2020)

What's missing?

- Full cross section: appointed a TF to assess efficiency systematics (N.Markov)
- Full statistics cooking (eg TCS or J/Psi): completion of RGA and RGB Pass1 in progress
- RG-F data calibration and cooking in progress
- Physics program on (heavy) nuclei: run in 2021 (RGM: SRC and e- for neutrinos)
- Spectroscopic program (MesonEx and VeryStrange): waiting for Pass2 cooking to include full alignment of the CLAS12-CD (appointed a TF for Pass2 cooking needs)

Credit: S.Diehl, C.Dielks, Latifa E., V.Ziegler

CLAS12

- demonstrated to exceed the expected performance
- Room for improvement for alignment, calibrations and efficiency

Data reconstruction

- Started massive cooking of 2y of data
- So far:
  - 13.5B triggers
  - 0.3PB raw →40TB DST →25TB skimmed
  - 4M core/hrs processing time
  - 600k jobs processed by JLab farm (SWIF) with 6 corrupted files …

IT resources

- Docker containers for RecSW distribution
- Off-site resources: OSG + INFN + UK for CLAS12 simulations

Machine Learning for CLAS12

- Tracking: speed (6x)
- Clustering
- RecSW handles both conventional and AI algorithms (validation)
- Expected improvement in efficiency and resolution
- Future: on-line reconstruction

Review outcome

- Status of HDice tests (mid October 2020)
- Alternative options for a transverse pol target (Mid Jan 2021)

Credit: V.Ziegler

Nuclear Inst. and Methods in Physics Research, A 959 (2020) 163419

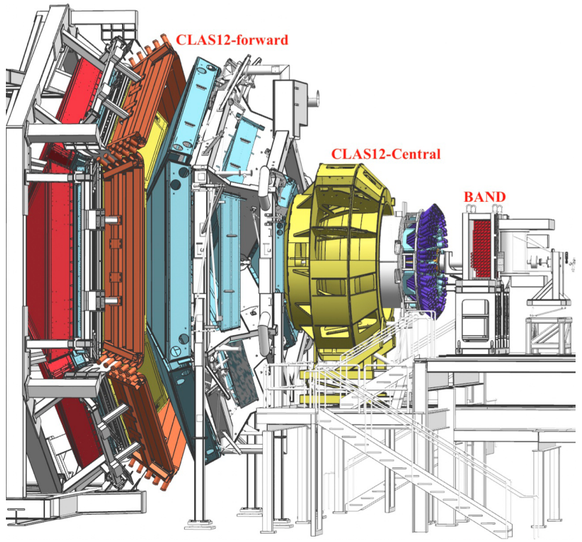
Contents lists available at ScienceDirect

Nuclear Inst. and Methods in Physics Research, A

journal homepage: www.elsevier.com/locate/nima

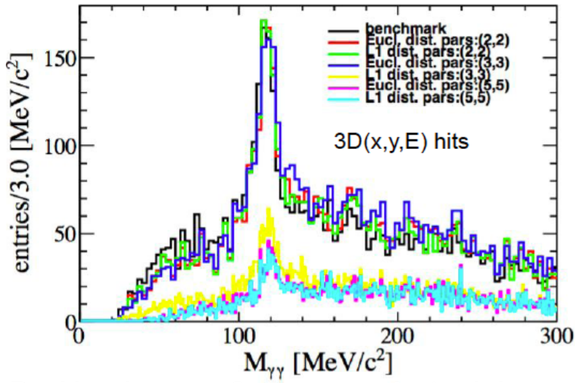
The CLAS12 Spectrometer at Jefferson Laboratory

Nucl.Instrum.Meth.A 959 (2020) 163419



Future plans

- **High Luminosity upgrade**: staged approach (TF), requires higher granularity tracker (GEM?)
- **Streaming RO**: first test in Feb performed using the FT-Cal, application of AI algorithms



Double cluster π0 mass as obtained by an unsupervised hierarchical clustering algorithm implemented in JANA framework by C.Fanelli

New proposals

Proposal ID	Hall	Title	Days	PAC
Letters of Intent				
LOI12-20-001	B	Measurement of the Neutral Pion Transition Form Factor and Search for the Dark Omega Vector Boson	30	
New Proposals				
PR12-20-002	B	A Program of Spin-Dependent Electron Scattering from a Polarized He-3 Target in CLAS12	30	A- C1
PR12-20-004	B	PRad-II: A New Upgraded High Precision Measurement of the Proton ChargeRadius	40	A C1
	B	Precision measurements of A=3 nuclei in Hall B	60	A- Approved
PR12-20-006	B	Precision Deuteron Charge Radius Measurement with Elastic Electron-Deuteron Scattering	40	deferred
PR12-20-009	B	Beam charge asymmetries for Deeply Virtual Compton Scattering on the proton at CLAS12	100	C2
		New beam time requested for Hall-B proposal	**270**	**270**
Run Group				
E12-06-106A	B	Nuclear TMDs in CLAS12	0	0
E12-09-007A	B	Studies of Dihadron Electroproduction in DIS with Longitudinally PolarizedHydrogen and Deuterium	0	0
E12-09-117A	B	Dihadron measurements in electron-nucleus scattering with CLAS12	0	0

- 1 approved experiment: Tritium target
- 2 C1 approved experiments: polarized He3 and PRad-II
- 1 C2 approved experiment: DVCS with a positron beam
- 1 deferred exp: DRad
- All 3 RG addition endorsed

Jeopardy

Experiment	Keywords	Recommendation
E12-12-002	GlueX II and Eta Factory	maintain status
E12-13-008	Pion polarizability	maintain status
RG A	Polarized e- on unpolarized H	maintain status
RG B	Deuterium target	maintain status
RG C	Longitudinally polarized target	approve for 120 days, then return to PAC
RG D	Color transparency	approve 30 days
RG E	Quark propagation	maintain status (see report)
RG G	EMC Effect in Nuclei	new grade A- (previously B+)
RG H	Transversely polarized target	maintain status
RG I	Heavy Photon Search	maintain status
RG K	Low-energy runs	maintain status

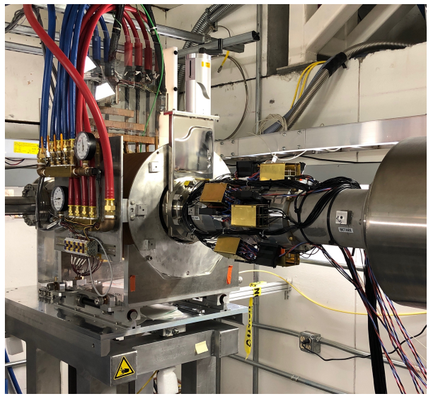
- RGA/RGK: control of systematic error and assessment
- RGB: highlight DVCS
- RGC: 120 days effect to the global landscape (return to PAC)
- RGD: 30 days low physics impact (more time after results)
- RGE: recommendation to have the 6 GeV data published!
- RGG: A- (from B+), important, high potential adding spin info
- RGH: comments on a transverse target
- RGI: competition with LHCb but still valid

- In support of CLAS12 run group (all transverse experiments designated as **High Impact** for Hall B)

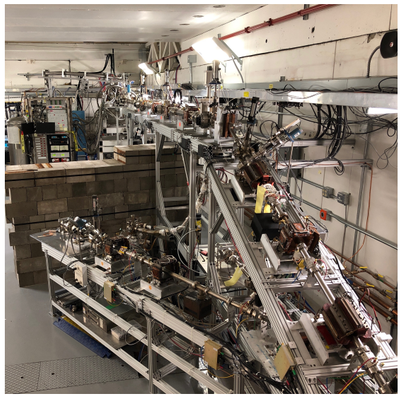
- challenge: trans. holding fields bend electrons into the detector !
- mitigation: small B•dL ⇔ frozen-spin HD

HDice target tests at UITF necessary to check depolarisation effects

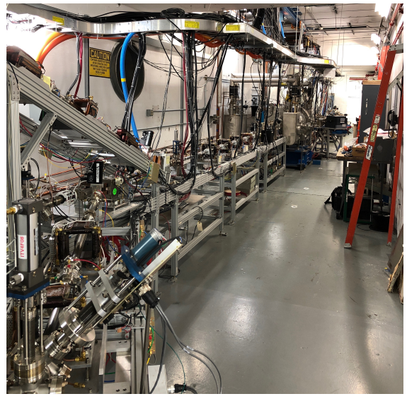
Work plan
- Run 0: booster at 0.5 MeV, 1 MeV, and 10 MeV
- Run 1: commissioning (beam line) ~19 days
- Run 2: run on UNpolarized HD ~17 days
- Run 3: run on Polarized HD ~28 days



HDice In-Beam Cryostat



cave-2 elevated beam line



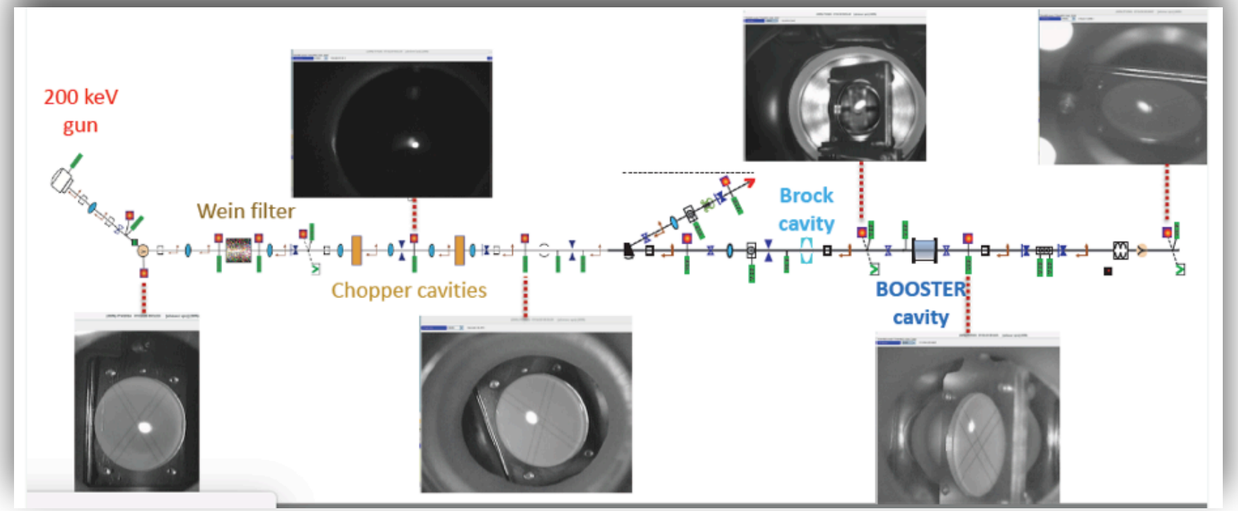
cave-1 with BOOSTER

Run 0

- Jul 22: UITF granted formal beam authorization for MeV beam to the cave-1 dump;
- July 31: 200 keV beam through BOOSTER to Faraday cup
- Aug 1-5: RF group works on BOOSTER; Klystron now delivering power to 2-cell buncher
- Aug 7: power to 7-cell; accelerate beam to **2.1 MeV**
- Aug 11-14 : accelerate beam to **4 MeV, 5.1 MeV, 7.2 MeV** 10 uA CW
- Aug 18 : accelerate beam to **8 MeV**
- Aug 19 : CTF liquefier issue; forced to stop and warm to 80K, END of Run 0

	ε_x (x 10^{-8} m-rad)	β (m)	ε_y (x 10^{-8} m-rad)	β (m)
measured:	3.291 ±0.009	183 ±5	2.343 ± 4x10^{-5}	17 ±3x10^{-4}
design:	4.015	2.5	2.555	75.4

⇔ *high- quality beam* !



Credit: A.Sandorfy

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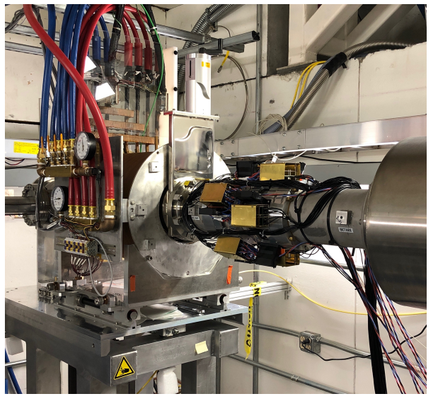

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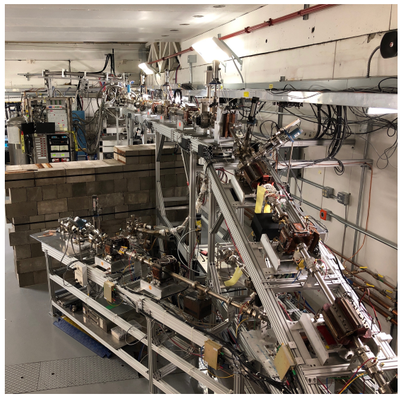
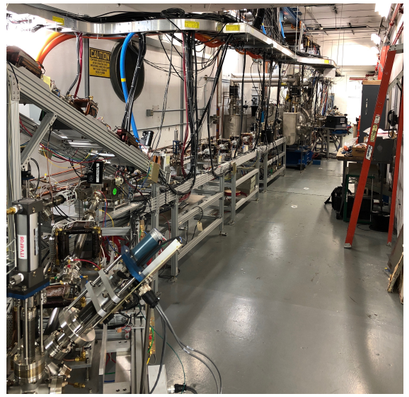


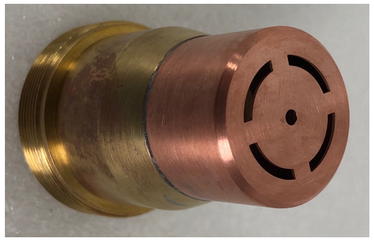
cave-2 elevated beam line



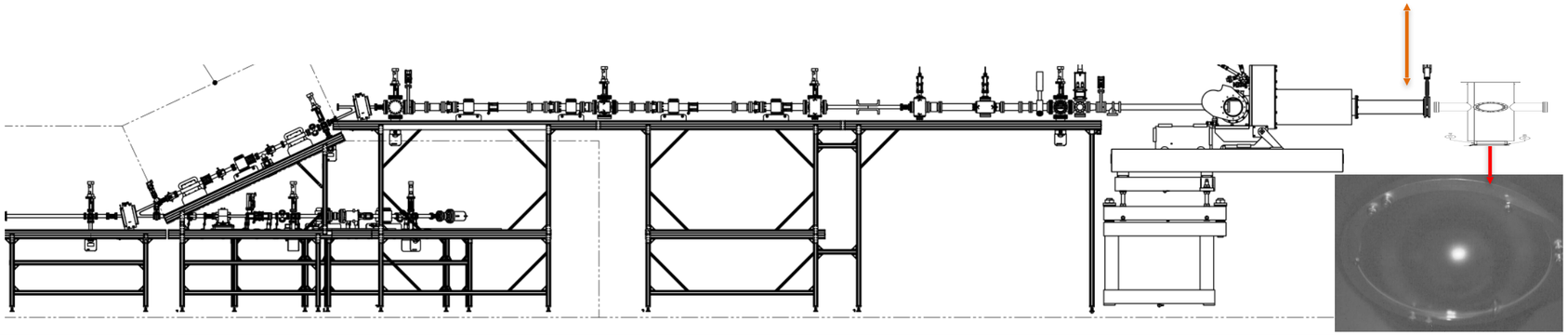
cave-1 with BOOSTER

Run 1

- Aug 28: **DOE granted UITF approval for OPERATIONS** (beam in Cave-2/HDice)
- Sept 1: **9.5 MeV** beam established
- Sept 4: raster tests converged (amplitude: spiral 150-350 kHz)
- Sept 11: first beam to the chicane
- Sept 20 IBC cooled at 60 mK with copper target; beam up to 25 nA CW, all magnets on
- Sept 28 Beam characteristics:



★ 9.5 MeV/c beam through the IBC to the dump
★ beam orbit centered on the axes of the 2 IBC solenoids and dump



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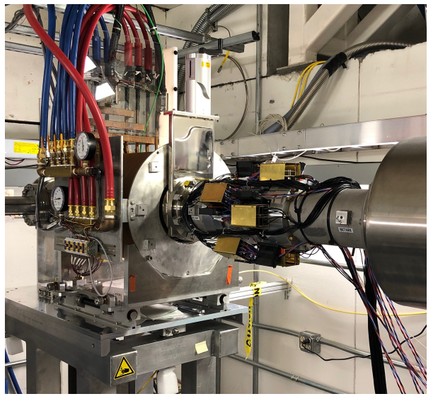

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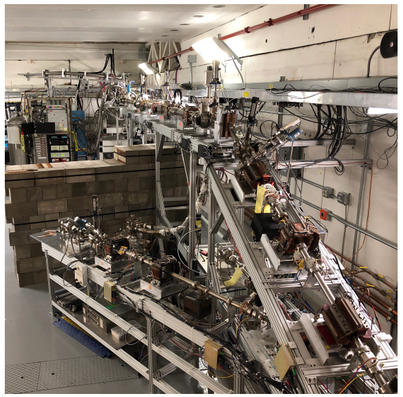
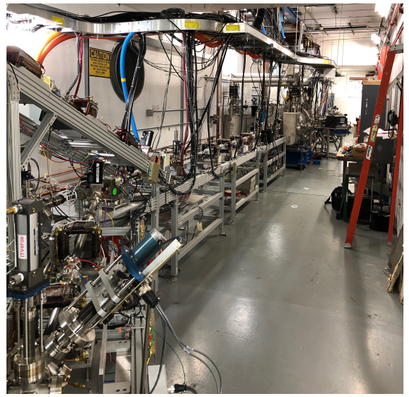


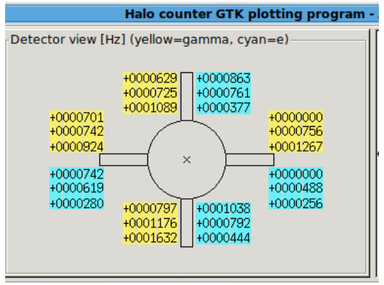
cave-2 elevated beam line

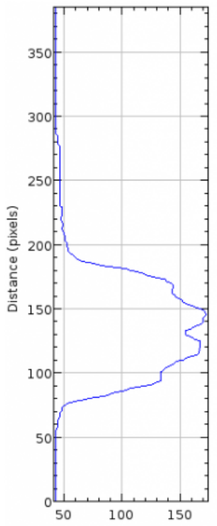


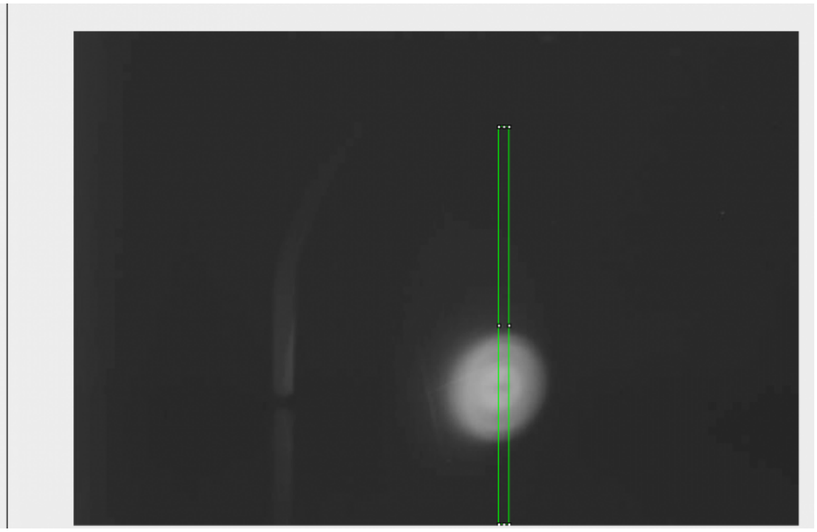
cave-1 with BOOSTER

Run 2

- Oct 27 - Nov 9: Beam on unpolarized HD target
- NMR thermal equilibrium signal in the IBC (P_H~1.4%)
- Good control on beam position
- Raster ready for Run3
- Measured Eloss from 10 MeV beam to calculate 10 GeV conditions
- Measured NMR signal with bema on/off







Run 3

- Beam on polarized HD target
- Expected from Nov 16 to Dec 16

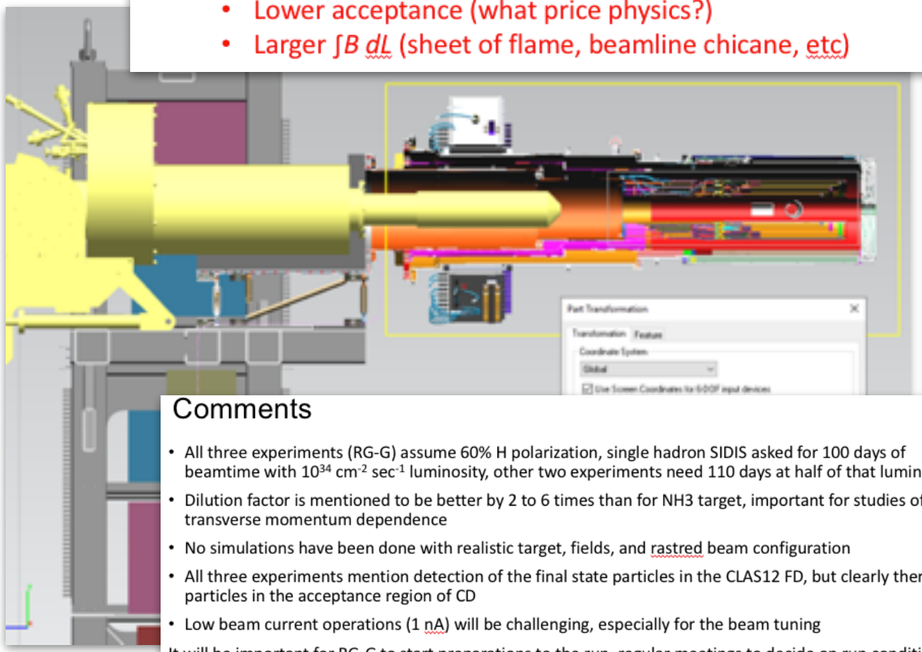
Credit: A.Sandorfy

Transvere Polarized target alternatives

- Working with the Target Group and Hall-B TF on possible alternatives for a polarized transverse target in Hall-B
- pol target technologies, impact on CLAS12, impact on approved physics program

The Plan B solutions I envision fall into one of two obvious categories

1. Target INSIDE the CLAS12 Solenoid
   - Higher acceptance
   - How to deal with the solenoid's longitudinal field? (MgB_2)
2. Target OUTSIDE the CLAS12 solenoid
   - Target is far simpler – no R&D, guaranteed performance
   - Lower acceptance (what price physics?)
   - Larger $\int B\,dL$ (sheet of flame, beamline chicane, etc)



Comments

- All three experiments (RG-G) assume 60% H polarization, single hadron SIDIS asked for 100 days of beamtime with 10^{34} cm^{-2} sec^{-1} luminosity, other two experiments need 110 days at half of that luminosity
- Dilution factor is mentioned to be better by 2 to 6 times than for NH3 target, important for studies of transverse momentum dependence
- No simulations have been done with realistic target, fields, and rastred beam configuration
- All three experiments mention detection of the final state particles in the CLAS12 FD, but clearly there are particles in the acceptance region of CD
- Low beam current operations (1 nA) will be challenging, especially for the beam tuning

It will be important for RG-G to start preparations to the run, regular meetings to decide on run conditions and a realistic detector configuration. Simulations with rastered beam, field and detector configurations necessary (may be they already doing it).

Transverse Polarized Target for CLAS12

Goal

In collaboration with RG-H find options for a polarized transverse target in CLAS12 optimizing the CLAS12 configuration and providing an updated physics reach for each option

Charge

- In coordination with RG-H team define (few) options of a polarized transverse target for CLAS12 that includes HDice and alternatives
- Per each option:
  - Define target tech specs
  - Define effects on CLAS12
  - In coordination with RG-H team study and propose possible solutions to complement the existing CLAS12 configuration
  - In coordination with RG-H team define effect on proposed physics program of each option
  - Define FOM that includes all aforementioned information
  - Identify tests to prove the chosen technology to be performed with existing equipment (magnets, cryostats, shielding …)
  - Make an assessment on the necessary R&D and resources needed

Resources

- Time: 7 months (Sept - March)
- Deliverable: 2 page report, wiki page with full documentation and minutes of meetings/presentations
- Task force: E.Pasyuk (PI), X.Wei (core), H.Avakyan (core), Latifa E. (core), M.Ungaro (simulations), B.Miller (external engineer), C.Keith (external), M.Contalbrigo (RGH representative), Sangbaek Lee (external), Patrick Moran (external), Robert Johnston (external)

C.Keith, E.Pasyuk, S.Stepanyan

^{3}He polarized target for CLAS12

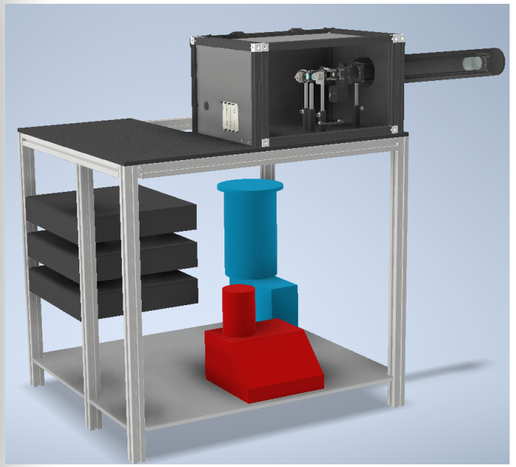
Motivated by the significant interest expressed by PAC48 (and C1- A- proposal rating!)

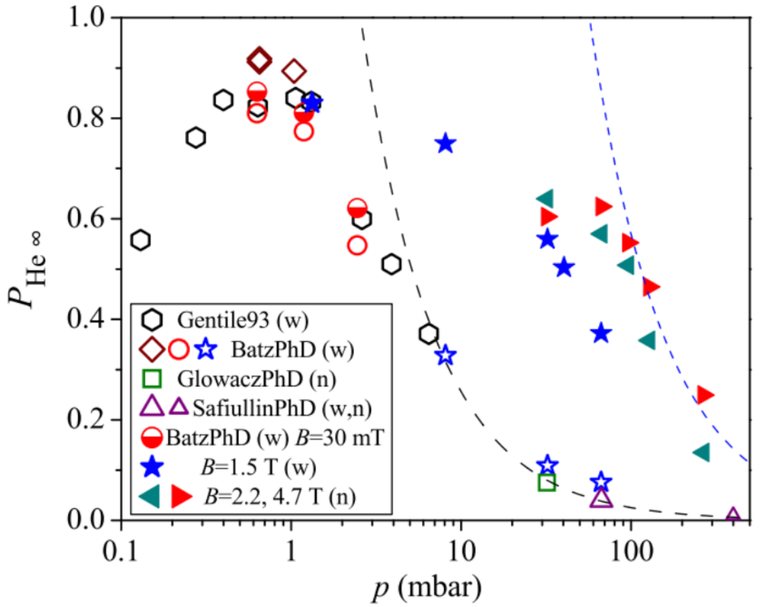
- Target Group, Hall-B and MIT join R&D activity lead by J.Maxwell to demonstrate the technical feasibility
- Proposed work plan
  - Establish and explore high-field MEOP at JLab
  - Map polarization performance vs pressure, magnetic field)
  - Start with experience from MIT-BNL
    - Understand gas transfer between cells (Diffusion sufficient? Controlling convection)
    - Understand depolarization in beam (Relaxation higher with increased pressure, lower with increased field Final answer will require beam on target

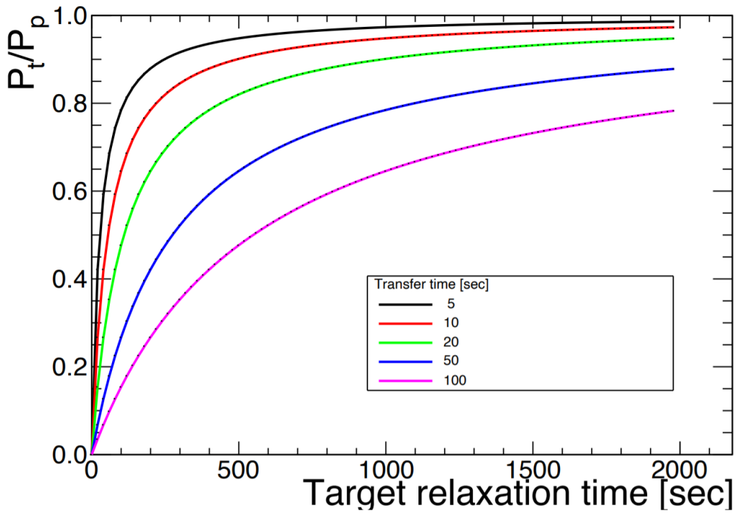
Three Year Plan

- Year 1: Using minimal equipment and space, address two topics:
  - High field polarization at RT, range of pressure and field
  - Gas transfer between cold and RT cells
- Year 2, 3: Build working prototype
  - Need pulse-tube, cryostat, dedicated lab space, more personnel
  - Explore performance of full system
  - Designed to allow simple upgrade to beam-ready system
- Beyond: In-beam tests in UITF
  - Measure in-beam relaxation at high field

MEOP Test Stand







Credit: J.Maxwell, R.Milner, Dien Nguyen, C.Keith, H.Avagyan

Hall B

Hall-B Agenda

PRadius PrimEx CLAS12 Heavy Photon Search

Hall-B Task Forces

Lab-wide

100% Future CLAS12 Trigger/DAQ (S.Boiarinov, G.Heyes)
100% AI support to CLAS12 sw (G.Gavalyan, D.Lawrence)
100% Future CLAS12 Hi-Lumi (S.Stepanyan)

Hall-B

100% Forward tracking (D.Carman)
100% Central tracking (Y.Gotra)
100% CLAS12 software development (N.Baltzell)
100% BG merging (S.Stepanyan)
100% GEMC for streaming RO (M.Ungaro)
100% New polarised targets (E.Pasyuk)
100% Future CLAS12 PId (V.Kubarovsky)

Hall-B

90% CLAS12 data preservation (H.Avagyan)
80% Physics analysis framework (V.Ziegler)
55% Novel tracking technologies (Y.Sharabian) -> requires on-site access
Just started :Transverse polarized target options (RG-H) (E.Pasyuk)
just started: CLAS12 CD/FD efficiency assessment
being formed: RG-N (3He target) (H.Avagyan)

Run Grup support/integration

- *RG-L (ALERT) (D.Carman)*
- *RG-C support (V.Burkert)*
- *RG-M support (V.Kubarovsky)*
- *RG-I support (S.Stepanyan)*

AI task force Report

G.Gavalian, D.Lawrence, N.Baltzell, T. Britton, C. Fanelli, O. Hansen, V. Ziegler, D. Heddle, L. Elouadrhiri, M. Ungaro

CLAS12 Upgrade for H
Task Force S

Task Force member
L. Elouadrhiri, M. M
Advisors: N. Liy
Contributors: K. Gnanvo, S. E. Pasyuk,

Octol

Goals for the Upgrades

Stage-1: Achieve luminosity of ~ running with charged particle reco

Stage-2: Configuration of CLAS12 for operations at t nitude higher luminosity (10^{37} cm^{-2}s^{-1}).

Charge to the Task Force

- *Assess the current CLAS12 luminosity and identify the limiting factors (tracker granularity, integration time, readout, ...)*

showed promising results, more studies are needed to evaluate the detector performance.

- *Define a work plan to test the proposed solution with a time chart and milestones for:*

CLAS12 future DAQ and Trigger systems (June 24, 2020)

Task force: S.Boyarinov (co-PI), G. Heyes (external, co-PI), V.Kubarovsky (core), R.Paremuzyan (core), N.Baltzell (core), G.Gavalian (external), B.Raydo (external)

External advisors: B. Sa

Software Task Force Report

N. Baltzell (PI), G. Gavalian, M. Ungaro, V. Ziegler, R. De Vita (ext.), D. Heddle (ext.)

This task force met between March and June in 2020 to identify CLAS12 software infrastructure limitat and targets for increasing reliability, speed, and long-term maintenance. This document is the resu

Particle Identification Task Force Report

V. Kubarovsky, N. Baltzell, D.S. Carman, N. Markov, Y. Sharabi

October 22, 2020

Abstract

This document details recommendations for the short and long term tasks to mize the CLAS12 particle identification capabilities as identified by the CLAS1 task force.

1 Time-of-Flight Counters

- Short term work:
  - Implement algorithm for FTOF combined panel-1b/panel-1a timing: Oct. work to complete, expect up to 15% improvement in timing resolut
  - Implement optimized torus map: 6 months of work to complete includ ing shifted 4-momentum vs. p, θ, ϕ, and z-vertex, expect up to 20% in in momentum resolution.
  - Finalize alignment of 6-layer FMT: 6 months of work to complete, e 15% improvement in FTOF timing resolution due to improved vertex
  - Remove correlation of CTOF hit time on hit position along bar: 3 mon to complete, expect up to 20% improvement in timing resolution.
  - Complete reconstruction and alignment updates of CVT: 4 months complete, improvement in CTOF timing resolution TBD.
  - Recover lost signal in the CTOF due to remnant field: studies to be before next run with CVT installed, effect on CTOF performance TB
- Long term work:
  - Replace low resolution TDCs with high resolution TDCs: Plans incl being considered, expect 5% improvement in FTOF timing resolution
  - Investigate alternative technologies for Central Detector: New detecto gies could lead to a factor of 3 improvement in timing resolution and a momentum acceptance. Multiple years to investigate and complete R& if there is support.

Polarized targets task force report

Charge

1. Assess different option for CLAS12
2. For each option quantify:
   a. necessary steps to de
   b. timeline and mileston
   c. expected results
3. Evaluate the impact of each
4. Estimate costs and identify
5. Evaluate synergies with oth

Members

E. Pasyuk (PI), X. Wei (core), V. Burkert (

Additional external members: M. Lowry

Approved Experiments

- Run Group C: Longitudinally po E12-09-007(b), E12-09-009
- Run Group G: Longitudinally po
- Run Group H: Transversely pol
- Run Group N(?): Polarized ^{3}He

Longitudinally polarized target

For RGC and RGG the target is essential material: Run Group C will utilize NH_3 a

RGC target

The design and construction of the targ Group Laboratory. The tests included c Target and Fast Electronics Groups, and effort on the target will focus on constr final, beam-ready versions, and dynami

Timeline and resources for System C

Workforce resources: JLab Target Grou
Dec. 2020: System tests with electronics
Dec. 2020: Lower half target cart compl
Dec. 2020: Design and fabrication of be
Jan. 2021: Final version of JLab Q-meter
Nov. 2020: Lower half target cart compl
Feb. 2021: Beam-appropriate helium ba
Feb. 2021: Shim coils installed ($5k)
March 2021: Tests in EEL ($10k)
April 2021: FPGA NMR ready for tests
May 2021: Beam-ready bath for target
June 2021: Tests in EEL ($10k)
Aug. 2021: Pumps on pump cart ($20k)
Sept. 2021: Dress rehearsal -- Complete
Nov. 2021: Construction and installatio
Nov 2021: Design and construction for
Jan. 2022: System ready for installation
Feb. 2022: System ready for beam in Ha

RGG target

While the modifications to the longitud prepare the ^{6}LiH and ^{7}LiD samples for d irradiation must be used to create the F-centers in the mate

second step can be performed at the Upgraded Injector Test Facility and will require construction of a variable temperature irradiation cryostat. Construction and/or modification of a UITF beamline suitable for the irradiations will also be required. More details of this target can be found on the task force wiki

Forward Tracking Improvement Task Force Report

June 29, 2020

Members: Dan
Maxence Vand

Abstract

This document
of tracking effi
the time-scale

Tracking Imp

We have ident

- Improve tr
- Improve ef
- Improve th
- Improve th
- Validate tra

We identify 31
priority: HIGH
be assigned as

- Improve T

1. Finish up HIGH pri
2. Finalize t HIGH pri
3. Determin HIGH pri
4. Study cal MEDIUM
5. Devise pr HIGH pri
6. Study eff HIGH pri

- Long te

Central Tracking Improvement Task Force Report

July 17, 2020

Members: Yuri Gotra (PI), Veronique Ziegler (core), Mac Mestayer (core), Maurizio Ungaro (external, MC expert), Rafayel Paremuzyan (external), Maxime Defurne (external)

Abstract

This document identified areas in which the (efficiency, momentum resolution, and execut manpower requirements of the various tasks

Tracking Improvement Goals

We have identified five work areas to improv

- Improve track momentum and ang
- Improve tracking efficiency
- Tune MC simulation of the tracker
- Reduce the event reconstruction ti
- Validate tracking software and imp

We identified specific studies listed below to priority: HIGH (CY2020), MEDIUM (1-2 yrs), *assigned as service work items for the collab*

- Improve track momentum and ang

Geometry and Local Reconstruction

- Standardize helix definition and prope initialization, HIGH priority, 2 weeks,
- Implement and validate the methods geometry framework, HIGH priority, 2
- Improve cluster selection (BMT centr Lorentz angle corrections), HIGH prio

CVT Calibration

- Finish updating and validating the CC
- Document SVT/BMT calibration proce months, 0.2 FTE
- Study calibration stability *, MEDIUM

Central Tracker Alignment and Solenoi

- Stage 1: define initial SVT internal ali define global SVT alignment in X and standalone tracking, validate beam p
- Stage 2: using DC alignment approac MEDIUM priority, 7 months, 0.2 FTE
- Stage 3: develop and validate Kalma priority, 12 months, 0.5 FTE
- Quantify CVT misalignments on cosm
- Study effects of misalignments and L define most important degrees of free
- Study CVT momentum, angular, vert MEDIUM priority, 6 months, 0.5 FTE
- Devise procedure to align CVT relati *Tracking task force)*
- Study effects of track propagation in t FTE *(with Software task force)*

Beamline and Shielding Improvement

- Study tagger dump shielding options priority, 6 months, 0.2 FTE *(with High*

7. Study forward tracker alignment techniques (e.g. MILLIPEDE, Kalman Filter) HIGH priority, 6 months, 0.3 FTE
8. Study effect of different torus field maps on resolution and choose best map

- Improve tracking efficiency

Track Finding and Fitting Algorithms

- Implement and validate CVT/SVT straight track reconstruction, HIGH priority, 2 weeks, 0.2 FTE
- Develop and validate standalone Kalman Filter, HIGH priority, 2 weeks, 0.5 FTE
- Validate SVT geometry and standalone tracking, HIGH priority, 1 month, 0.2 FTE

Streaming CLAS12 with GEMC Task Force Report

Members: Maurizio Ungaro (PI), Sergey Boyarinov (core), Gagik Gavalian (core), Nathan Baltzell (core), Ben Raydo (core)

This document summa
readout from the CLAS
The ultimate goal is to

- a realistic estima
- a battleground t challenges on hi

The goal can be achiev estimates. Given the in opportunity for synergy

Event generators "stre

Description: provide a time, using the cross-se The authors are interes

Resources estimate: 0.1

Working around Gean

Description: a framewo

Resources estimate: 0.1

Streaming Readout U

Description: develop a network.
The project has three st

1. organize geant4
2. write SRU strean
3. broadcast each

Resources estimate: 0.3

Voltage vs time signal shape from a "geant4 hit"

Description: a framework to provide a voltage as a function of time based on steps.

CLAS12 FD charge particle reconstruction efficiency and the beam background merging Task Force report

Task Force members: S. Stepanyan (PI), M. Ungaro (core), V. Ziegler (core), H. Avagyan (core), N. Markov (external), V. Burkert (external), R. De Vita (external)
Contributors: N. Baltzell, FX. Girod, J. Newton

October 5, 2020

Introduction

The task force, together with the software group, achieved its goals of developing and validating software packages to account for background hits in the CLAS12 detector elements in data and MC. The software package and its usage can be found on the software group wiki. With the background merging, the charged particle reconstruction efficiency and the momentum resolution at high luminosities are reproduced within a few %. The largest discrepancy was between the inclusive electron reconstruction efficiency in data and background merged MC, amounting ~ 4% at 40 nA.

Below is the charge for the task force with responses:

- *Develop a software for merging hits in fADCs and TDCs in CLAS12 detectors associated with physics (GEMC or exp. data) and the beam background (from the random trigger) events:*
  The package "bg-merger" has been developed and used to validate the background merging process. The tool is in use now by large group of collaboration,
- *Develop software for filtering out hits in fADCs and TDC associated with beam background using random trigger events:* the "ttrigger-filter" and "trigger-splitter" packages are for filtering and organizing the background events into *hipo* files of required size

- *Study the dependen accuracy on the k using experimenta invariant and mis* and the momentu yields, SIDIS pion dences of the effic The dependence w Reconstruction eff final state lower th
- *Validate backgroun cies with results o nosity data:*
  There have been s and physics reactio exclusive and semi rized as follows:
  1. the reconstru the beam cur This has been studies. In b ity data repro
  2. the SIDIS MC of pion recon ing mass reso
  3. electron recon reproduced i
  4. different proc and show the
  5. track reconst nA of backgr
- *Document the wor*
  A note has been w More on the task f https://claswe Forces_2020_-_B

Long range - FY21 schedule

- **Schedule**
  - **FY21: long CEBAF shutdown for CHL Cold Box repair (Scheduled Accelerator Down - SAD)**

- Decommissioning of installed components: BONUS
- Maintenance of several detectors
- Installation of the next experiments (HPS, RG-M requires nuclear targets)
- Weekly meeting to plan the activity
- Regular report at Monday meeting
- Update on a dedicated wiki page: https://www.jlab.org/Hall-B/clas12-web/sad-2021-update.html

Hall B Long range - FY21 schedule

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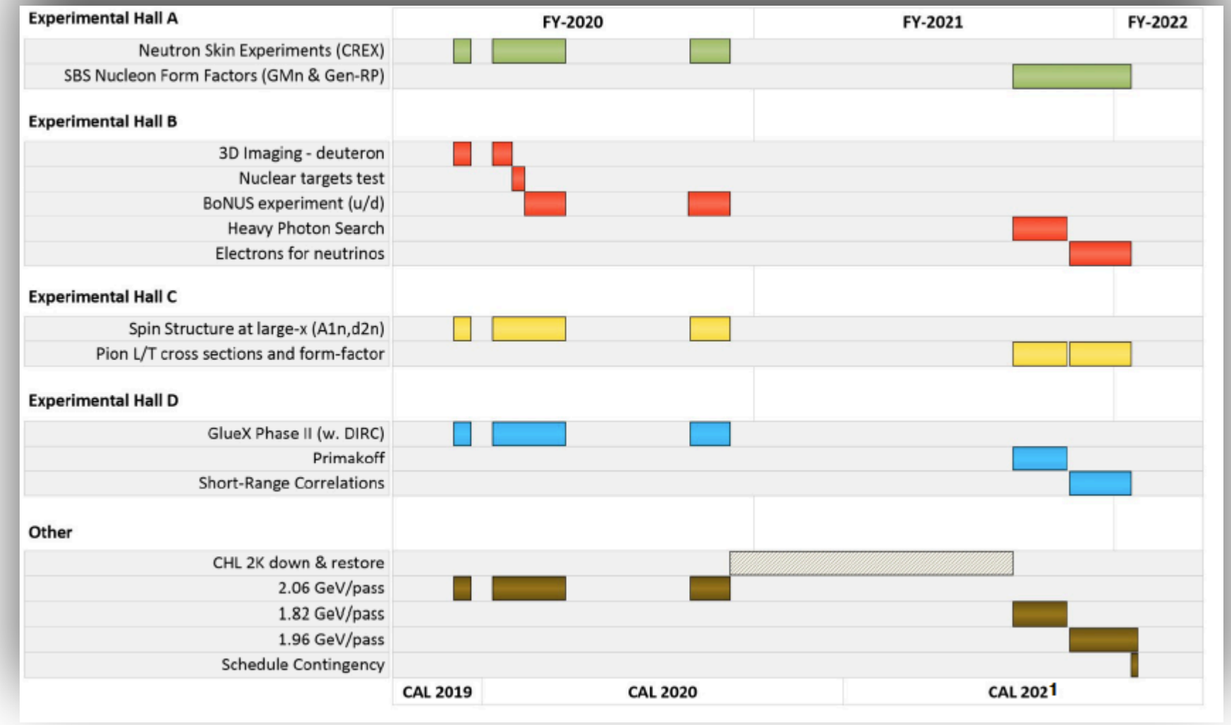
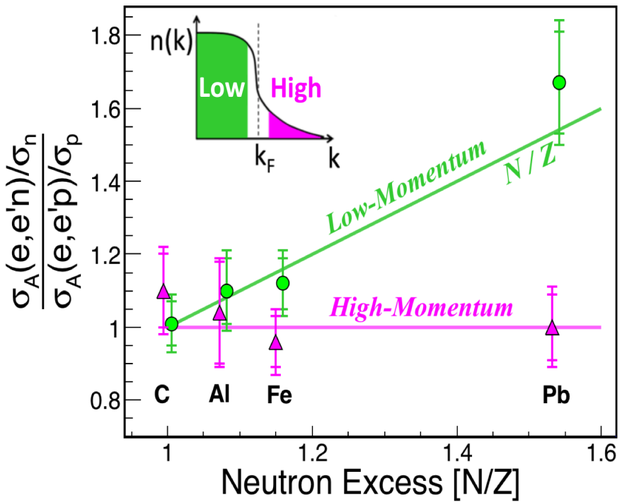
- **FY21: 20 weeks (Jun-Oct), 10.9 max E_b, only two RGs that requires low beam energy will be able to run (HPS and RGM)**



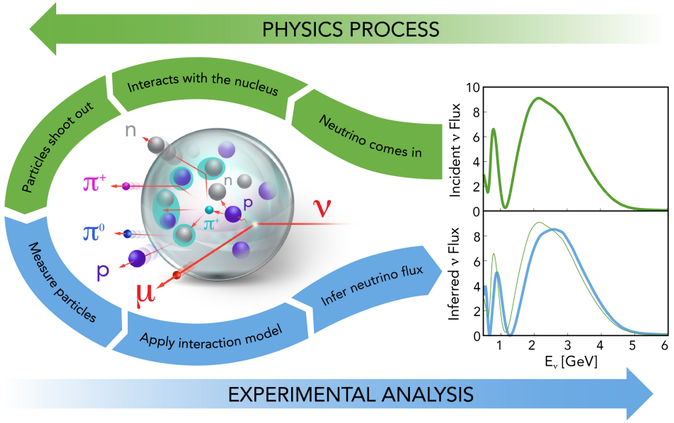
Short Range Correlations

- 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 Status

- Scheduled for 30 PAC days: August-October 2021
- D, 4He, C, [O,] 40Ar, 40Ca, 48Ca, Sn
  - Targets designed and under development
  - Standard liquid target cell
  - Short 0.5-cm Ar liquid target cell
  - Solid target C, Sn insertion mechanism
  - Special Ca target holders
- [1,] 2, 4, 6 GeV
  - Outbending at 2 GeV
- Standard CLAS12 plus BAND, no FT or LTCC
- Simulations underway to optimize
  - Trigger
  - Torus field

Hall B Long range - FY21 schedule

PRadius PrimEx CLAS12 Heavy Photon Search

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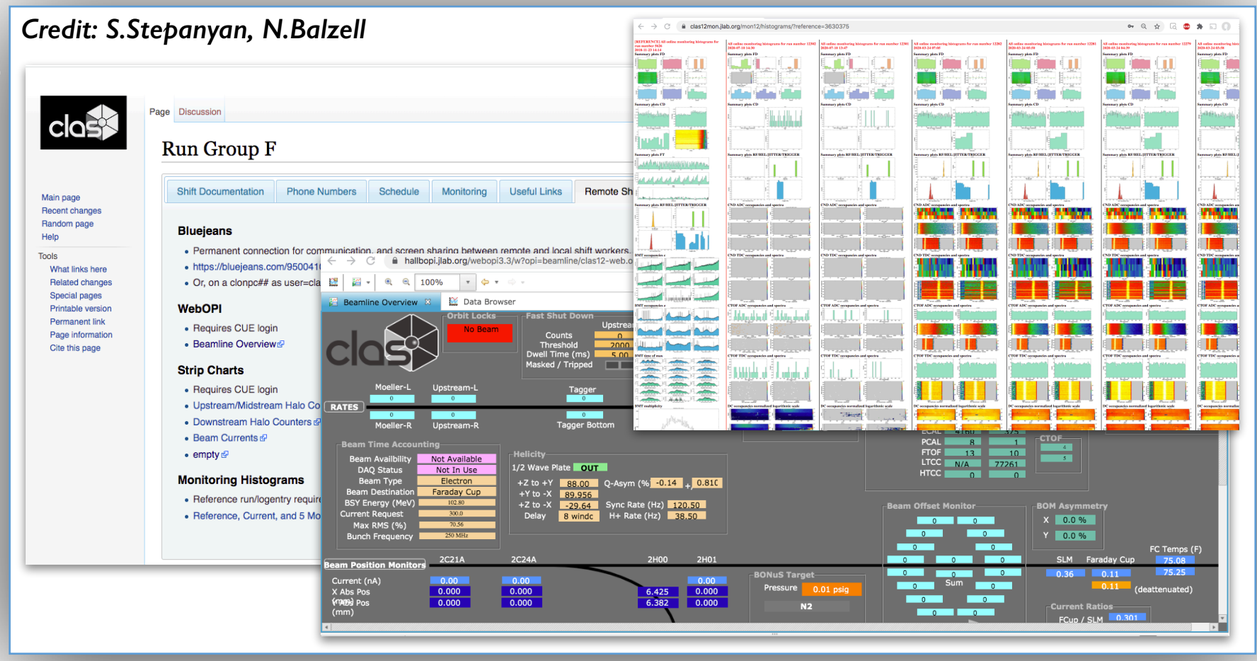
- **FY22 (tentative): polarized longitudinal target**
- **… : nuclear targets, transverse polarized target, completion of RGA, RGB, RGK, HPS, …**
- **… : new proposals (PRAD-II, polarized 3He, tritium target, …)**

- **Lesson learned: CLAS12 remote shifts went pretty well**

  Remote shifts for monitoring and support onsite personnel
  - only monitoring (no DAQ or control detectors)
  - home-like network connection + BJ to communicate with the Counting House

  Should we extend the remote shifts to regular CLAS12 operations?

Credit: S.Stepanyan, N.Balzell



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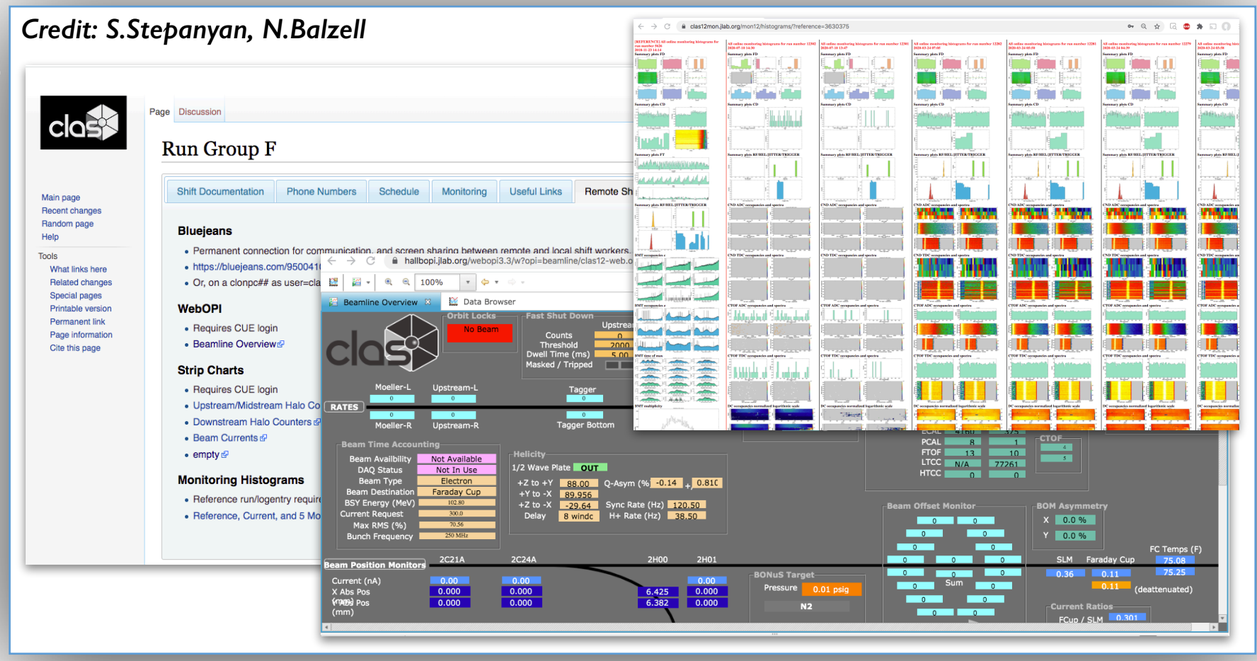

In summary:

… difficult time but:

- Difficult times but JLab was able to complete the experimental program planned for FY20
- Hall-B staff members and collaborators are doing their best to provide data ready for physics analysis