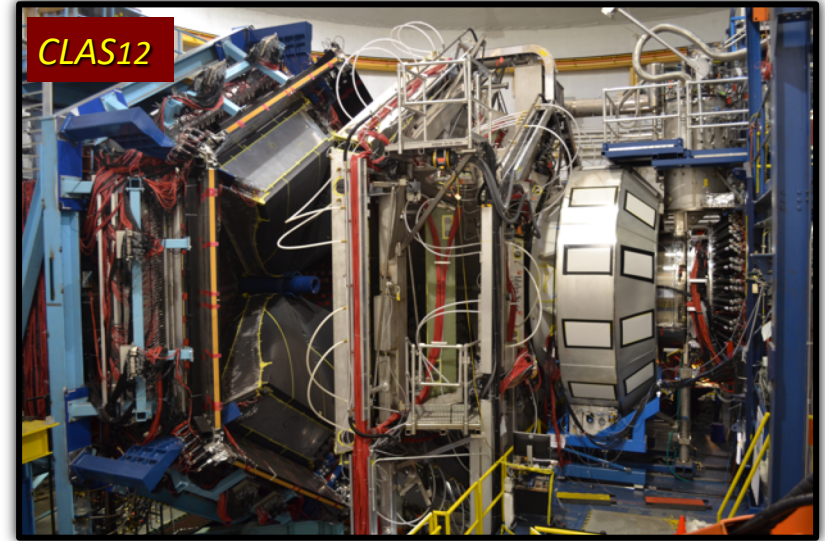
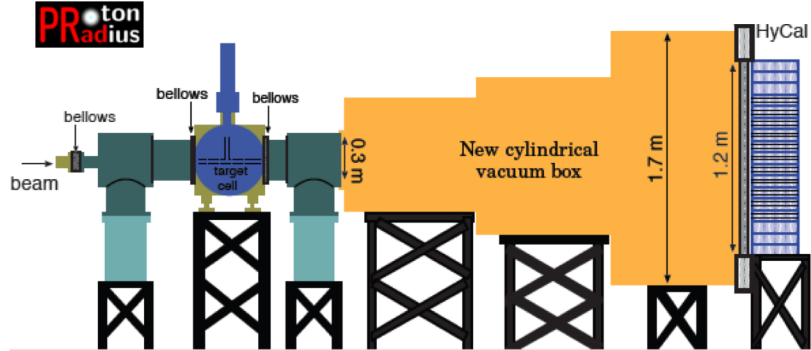
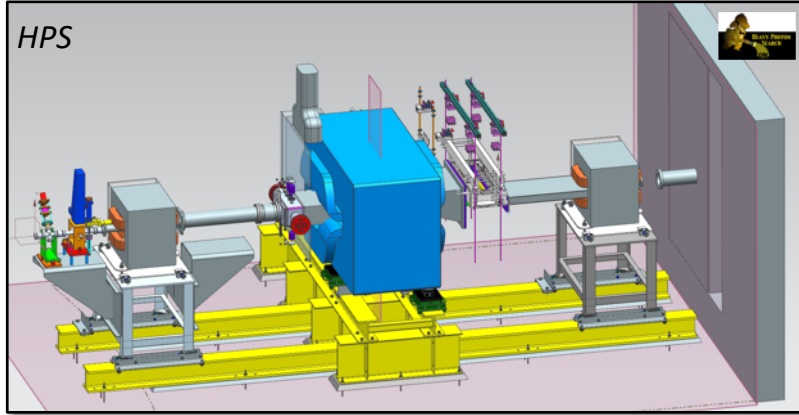




CLAS Collaboration Meeting
November 12 -15, 2019

Status of Hall B

Marco Battaglieri
Jefferson Lab

Hall-B leadership

Our mission is to make JLab capable of running the best hadron physics program in the world

- **USERS** are our customers and OPS is our main assignment

Run the experiment

Detector operation, maintenance and test for new detector design

- Assign a staff to each system/subsystem (+ a deputy)
- Work closely with the Collaboration (Users/Experts)
- Info sharing (web page)
- Full involvement of engineers and tech staff
- Work closely with other lab Divs/Res (FastElectronic, IT, CODA, ACC, DSG)

Provide data for physics analysis

From raw data to 4-vectors

- SW REC + MC framework (data format, DB, distribution to Users, explore new avenues e.g. AI)
- Lead/steer CALIBRATION and COOKING effort
- Work closely with the Collaboration (Users/Experts)
- Work closely with other lab Divs/Res (CC, IT, other Halls experts) for a common framework definition

Data preservation

Store data for a true future use

- CLAS data mining effort showed this is a valuable opt
- Set the framework for a true OpenAccess
- REC/MC/GEN distribution together with data
- Work closely with the Collaboration (Users/Experts)
- Work closely with other lab Divs/Res (CC, IT,)

Physics Analyses

- All Hall-B staff involved
- Stimulus for Users
- link with other Lab resources (TheoryGroup, JPAC, Femtography Center)

Hall-B organization

**Offline
+
framework, tools,
reconstruction and high-
level analyst
+
CLAS Coll SW
Coordinator**

- G.Gavalian - SW Architect
- M.Ungaro - Simulations
- V.Ziegler - algorithmes/validation
- N.Baltzell - Computing infrastructure
- N.Markov - Data processing
- **New hired** - Rec support
- + **W.Phelps (CNU)** - Data process support
- + **D.Heddle (CNU)** - CED

Detectors/Hall

- S.Stepanyan (Deputy) - Operations
- A.Sandorfi - HDIce & Team
- M.Mestayer - DC
- Y.Gotra - SVT/MM
- D.Carman - FTOF/CTOF/CND
- E.Pasyuk - Beam-line/FT
- V.Kubarovsky - RICH/LTCC
- Y.Sharabian - HTCC/LTCC
- **C.Smith** - ECAL/PCAL
- R.Miller - Lead engineer & TechStaff

Calibration/Analysis

- L. Elouadrhiri - First experiment
- D.Carman - CALCOM

Online

- S.Boyarinov - DAQ
- V.Kubarovsky - Trigger
- **New hired** - L3 trigger
- N.Baltzell - Slow control

Physics programs

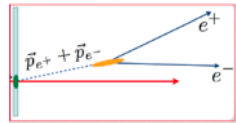
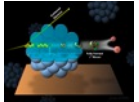
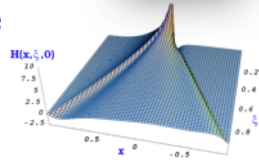
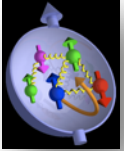
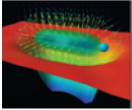
- V.Burkert - New avenues
- H.Avakyan - DIS/perturbative
- E.Pasyuk - Dedicated runs
- V.Mokeev - Resonance/non-perturb.
- S.Stepanyan - BSM
- + **A.Vossen (Duke)** - DIS/perturbative

R&D

- Y.Sharabian - Detectors
- S.Boyarinov - Streaming RO
- G.Gavalian - AI

JLab Scientific Mission

- What is the role of gluonic excitations in the spectroscopy of light mesons?
- Where is the missing spin in the nucleon? Role of orbital angular momentum?
- Can we reveal a novel landscape of nucleon substructure through 3D imaging at the femtometer scale?
- What is the relation between short-range N-N correlations, the partonic structure of nuclei, and the nature of the nuclear force?
- Can we discover evidence for physics beyond the standard model of particle physics?



Hall B science program is decisive in addressing these questions

Hall B Overview

101 CLAS members have registered for the collaboration meeting

CLAS12 first physics runs: RG-A (13 proposals, 139 PAC days), RG-K (3 proposals, 100 PAC days), RG-B (7 proposals, 90 PAC days), RG-C (BONUS, 185 PAC days)

Continued flow of results from Hall B (CLAS+PRAD+HPS+PRIMEX..)

- > 220 physics papers in peer reviewed journals (> 10,000 citations)
- 4 papers in Nature (+1 submitted), 1 paper in Science
- ~2,530 conference talks (~1,620 invited)

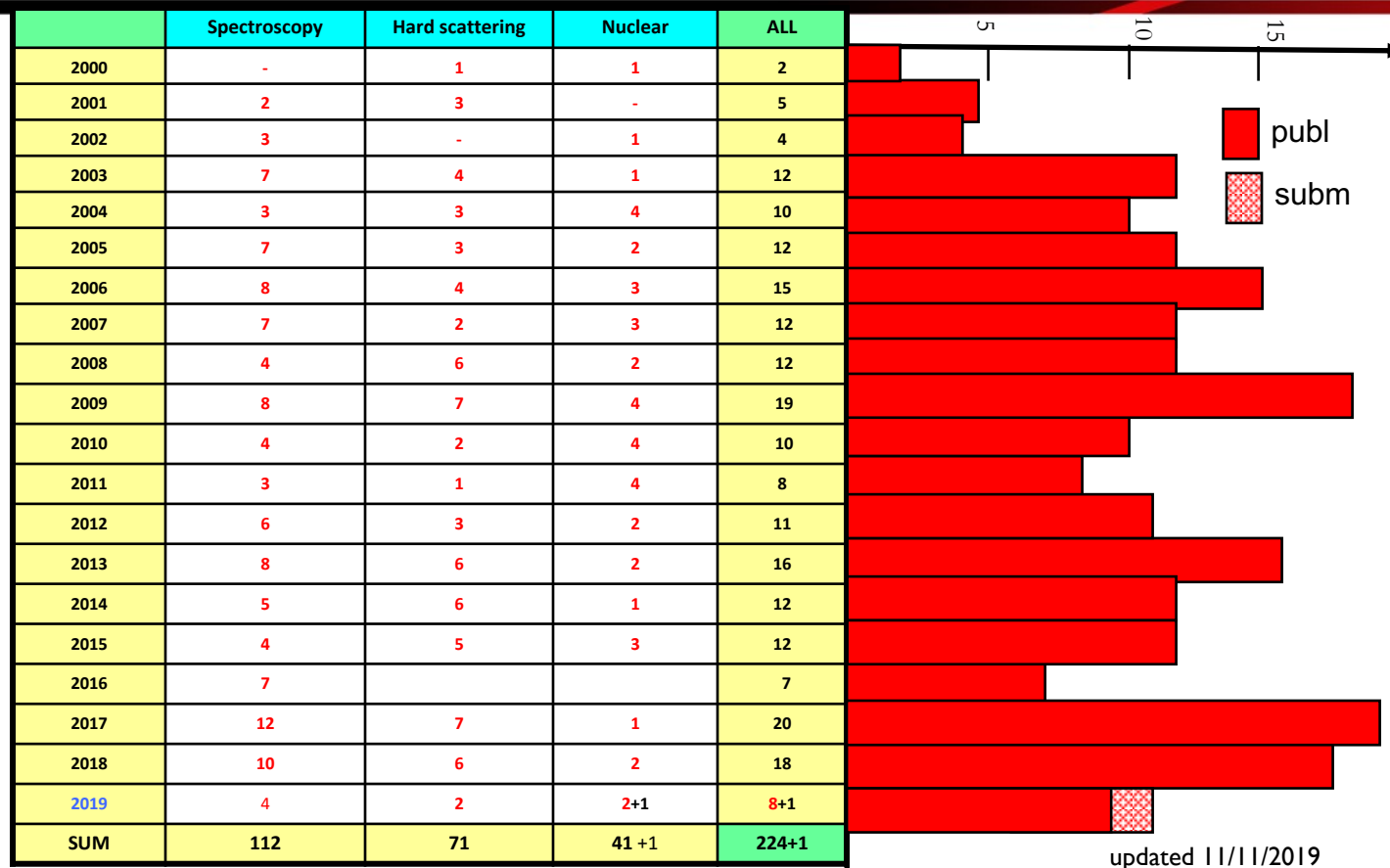
Specialized Hall B experiments

PRAD experiment – results published in Nature

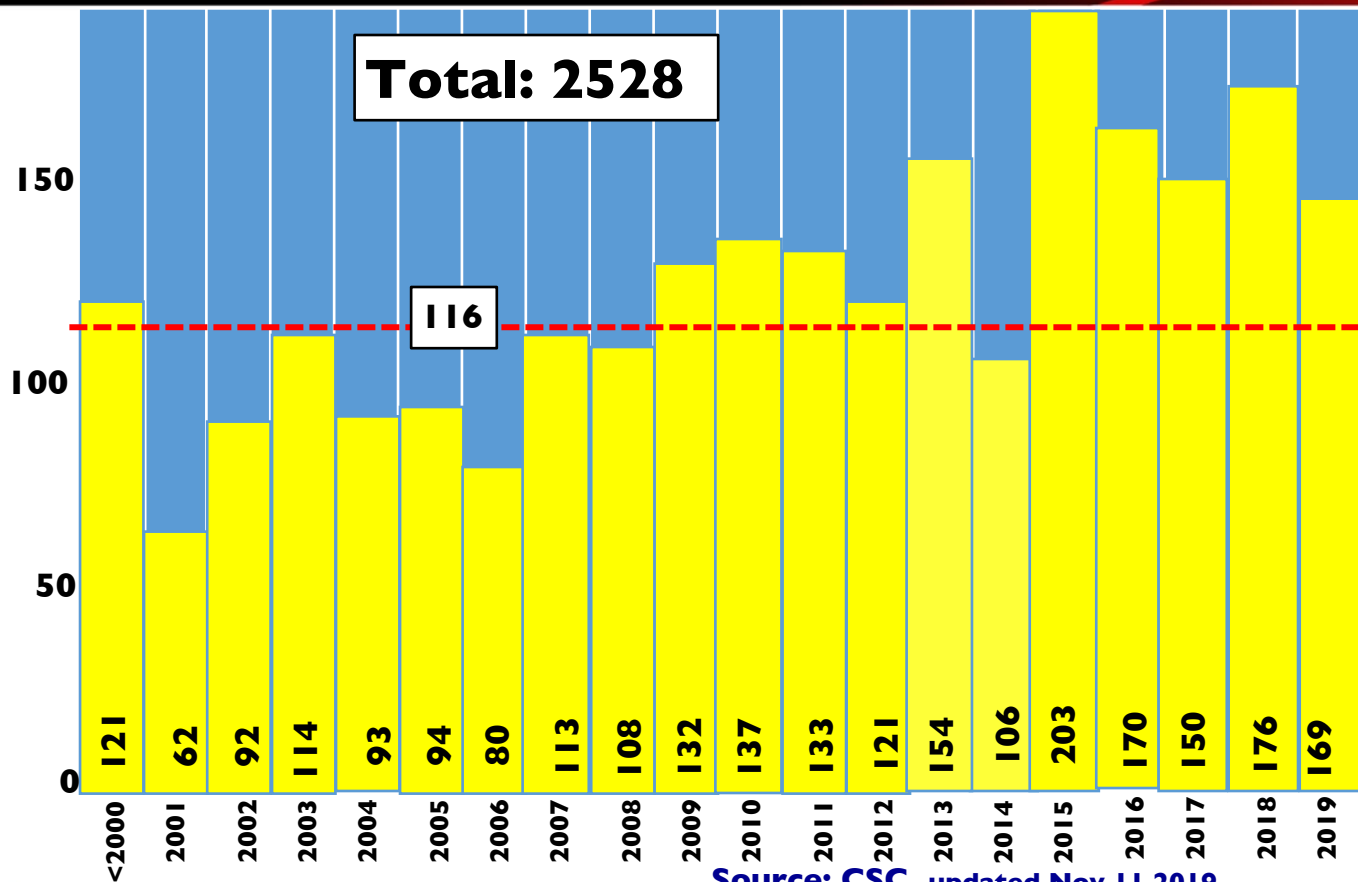
Heavy Photon Search - Analysis of 2016 data ongoing, 2019 run

Refereed Physics Publications

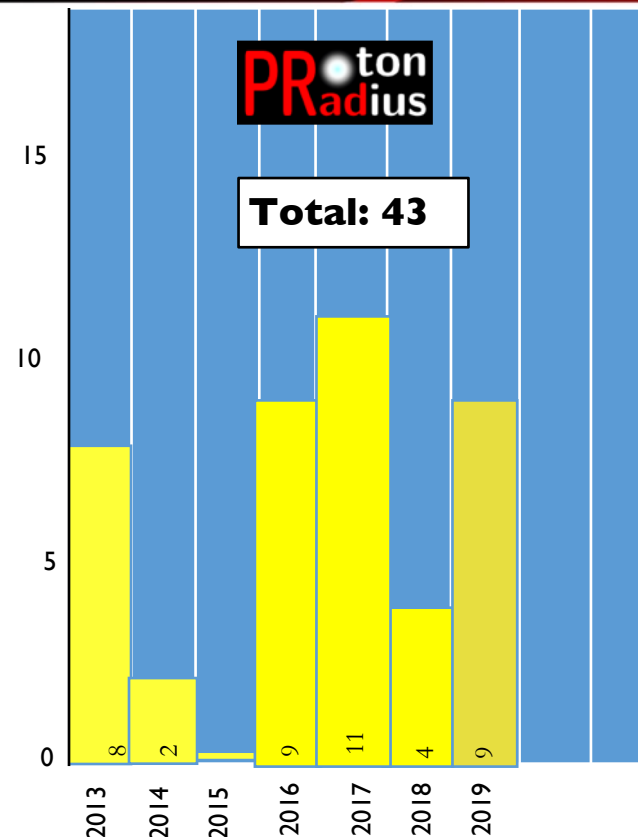
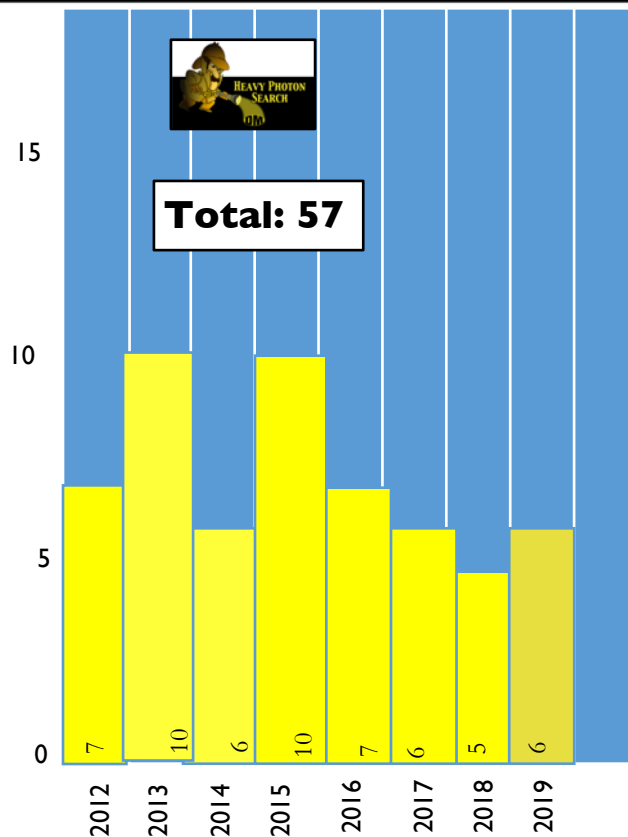
Hall B



Conference Presentations

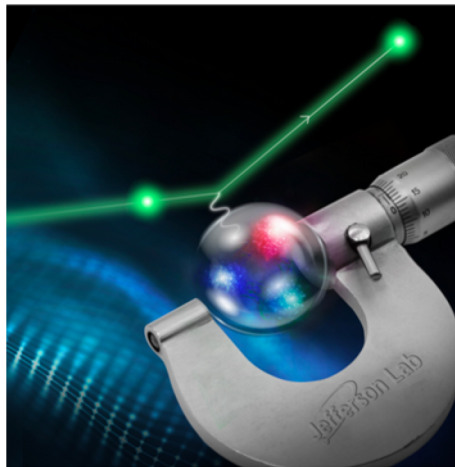


Source: CSC updated Nov 11 2019

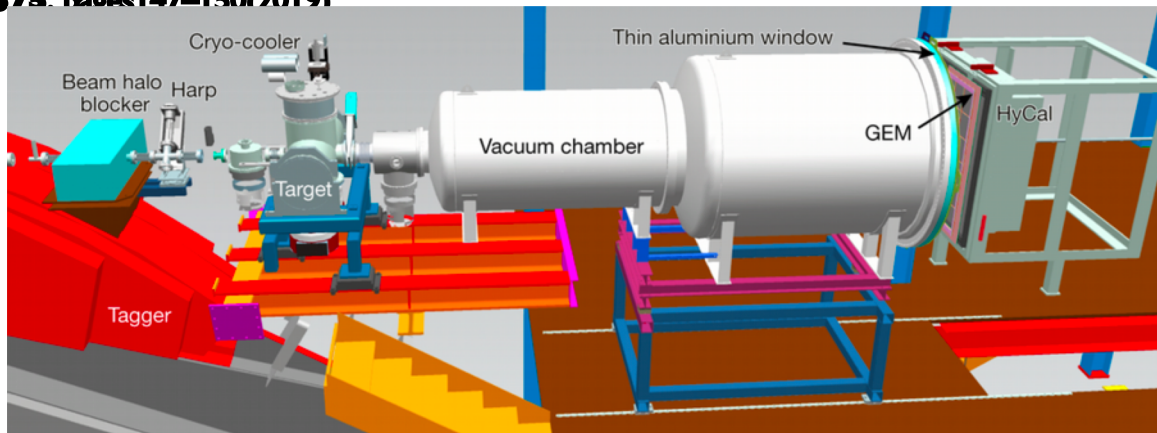


Source: HPS & PRAD wiki

updated Nov 11 2019



Nature volume 575, pages 147–150 (2019)



High precision experiment
 New windowless target system
 Use a calorimeter as a spectrometer
 Use e-e scattering to renormalise e-p scattering data
 Very small angle coverage

Article

A small proton charge radius from an electron–proton scattering experiment

<https://doi.org/10.1038/s41586-019-1721-2>

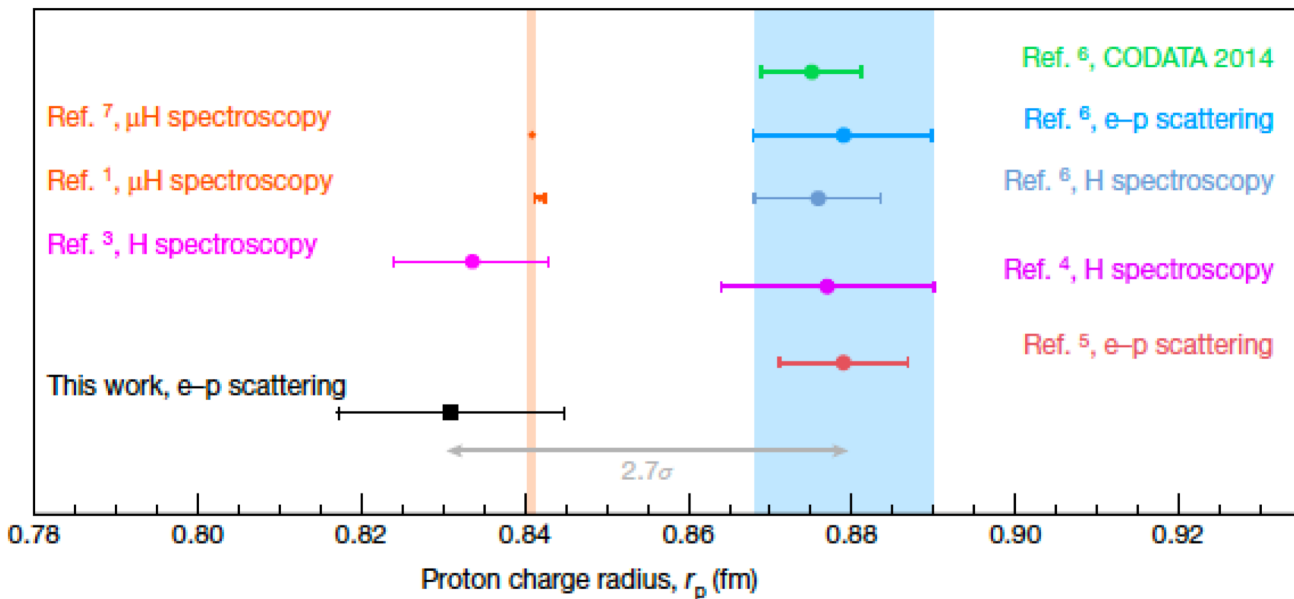
Received: 17 June 2019

Accepted: 19 September 2019

Published online: 6 November 2019

W. Xiong¹, A. Gasparian^{2*}, H. Gao³, D. Dutta^{4*}, M. Khandaker⁵, N. Liyanage⁶, E. Pasquy⁷, C. Peng⁸, X. Bai⁹, L. Ye³, K. Gnanvo³, C. Gu¹, M. Levillain¹, X. Yan¹, D. W. Higinbotham¹, M. Mezziane¹, Z. Ye¹⁰, K. Adhikari¹, B. Aljawrneh¹, H. Bhatt¹, D. Bhetuwal¹, J. Brock¹, V. Burkert¹, C. Carlin¹, A. Deur¹, D. Di¹, J. Dunne¹, P. Ekanayaka¹, L. El-Fassi¹, B. Emmich¹, L. Gan¹, O. Glamazdin¹, M. L. Kabir¹, A. Karki¹, C. Keith¹, S. Kowalski¹⁰, V. Lagerquist¹⁰, I. Larin^{10,11}, T. Liu¹, A. Liyanage¹², J. Maxwell¹³, D. Meekins¹⁴, S. J. Nazeer¹⁵, V. Nelyubin¹⁶, H. Nguyen¹⁷, R. Pedroni¹⁸, C. Perdrisat¹⁹, J. Pierce²⁰, V. Punjabi²¹, M. Shabestari²², A. Shahinyan²³, R. Silwal²⁴, S. Stepanyan²⁵, A. Subedi²⁶, V. V. Tarasov²⁷, N. Ton²⁸, Y. Zhang²⁹ & Z. W. Zhao³⁰

PRad found a proton radius closer to the spectroscopy results

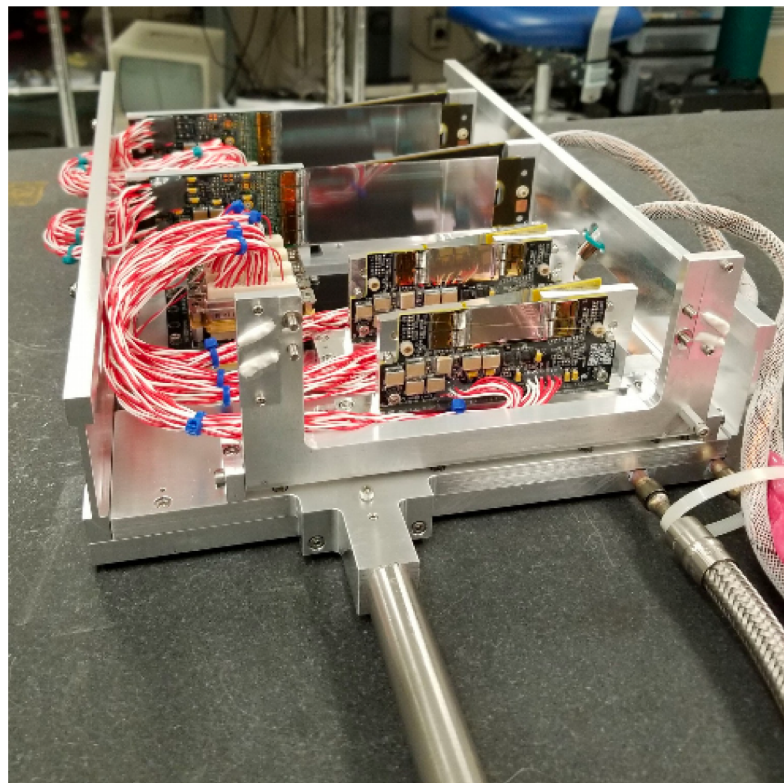
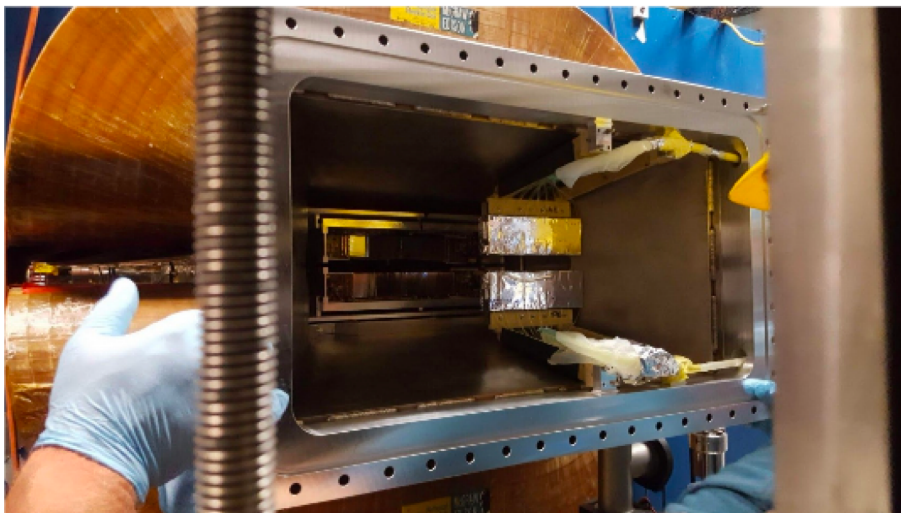


$$r_p = 0.831 \pm 0.007_{\text{stat}} \pm 0.012_{\text{syst}}$$

PRad Collaboration meeting: Dec 6 2019 JLab

HPS run during summer 2019

Two major upgrades: +1 layer Si tracker to extend the coverage and added a new hodoscope to trigger on e^+e^- pairs out of ECal acceptance



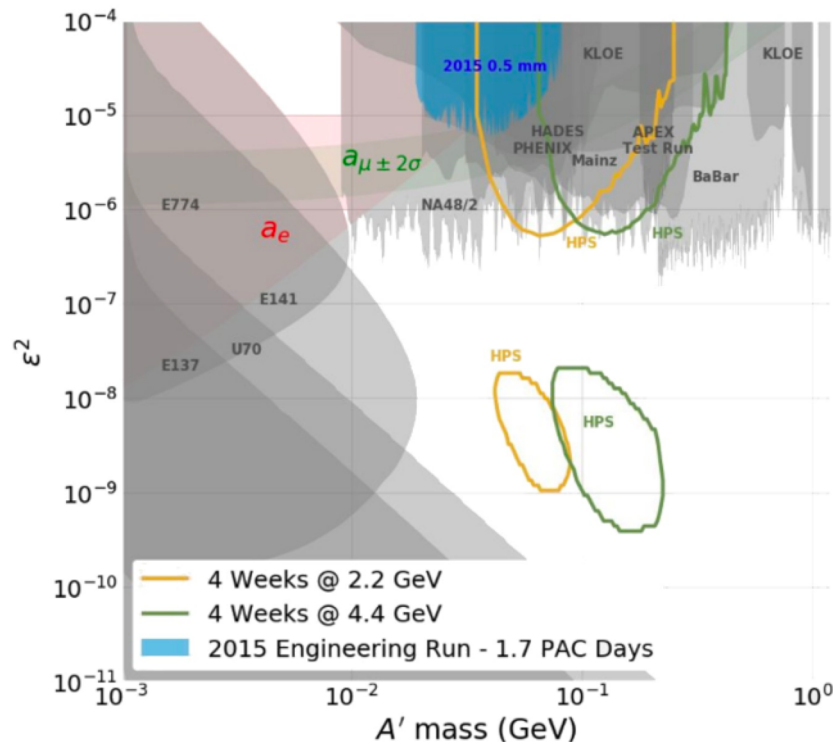
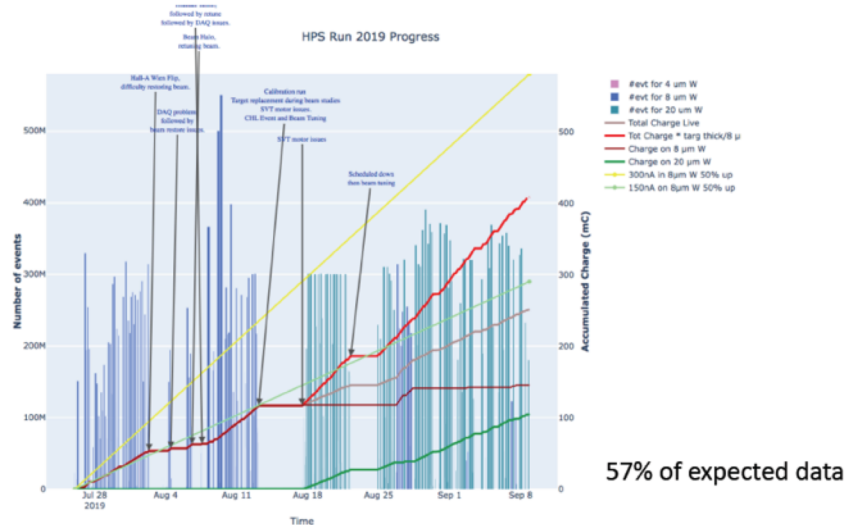


Heavy Photon Search

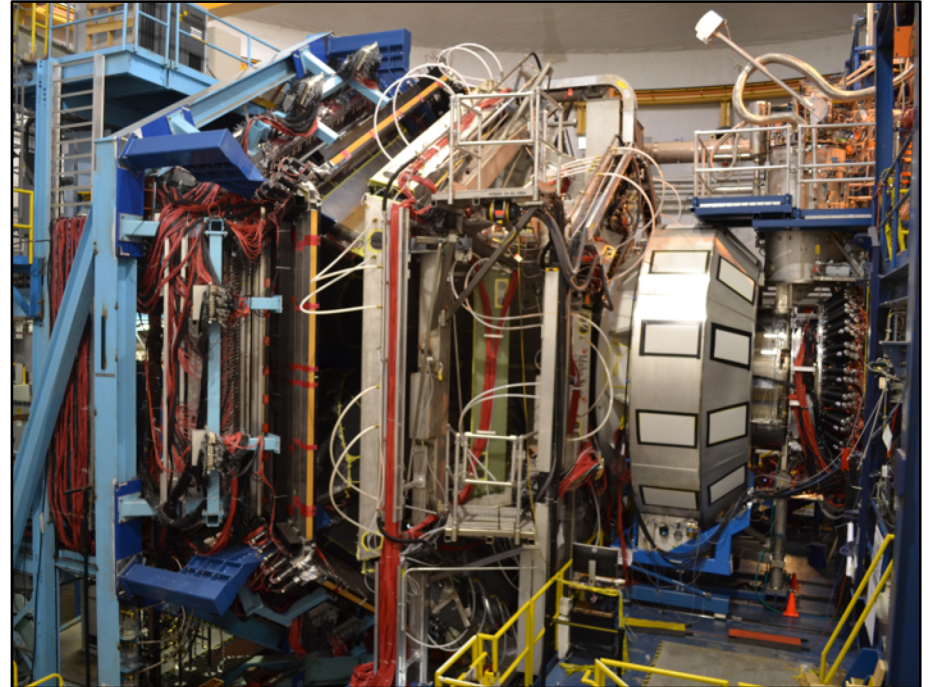
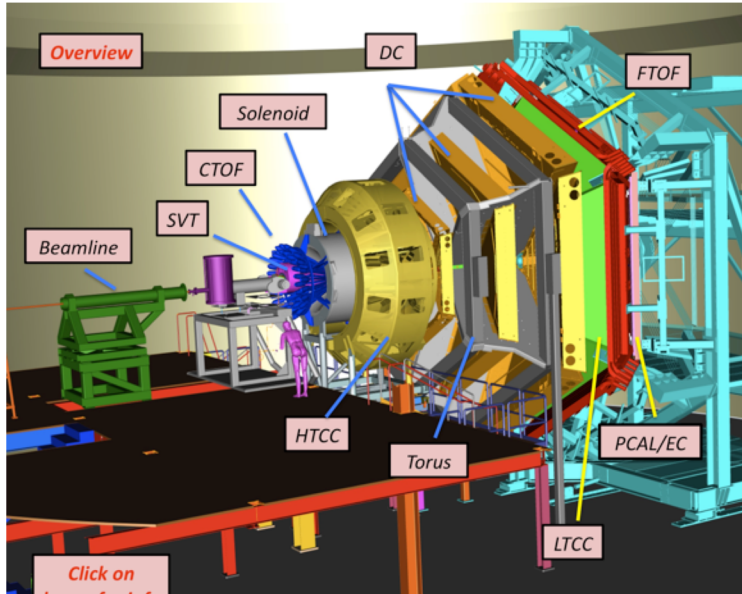
Hall B

Different combinations of energy (4.4 GeV), targets (8 μ m to 20 μ m) and currents (100-300nA)
Collected about 60% of the expected data

Data collected, as of Sunday 2pm



HPS Collaboration meeting: Nov 18-19 2019 JLab



CLAS12 data taking

from Feb 2017 (KPP) to Spring 2019 (physics runs)

– Run Group A:

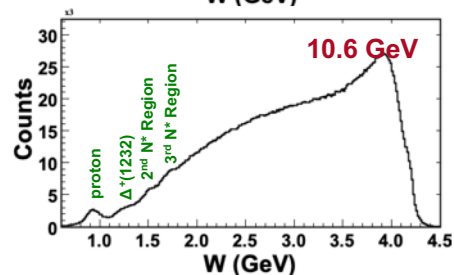
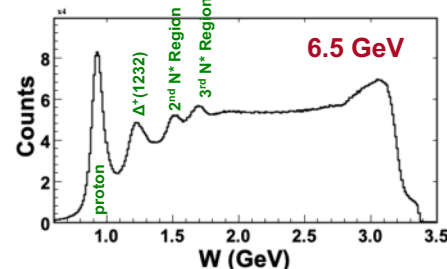
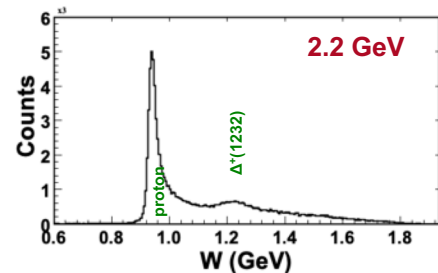
- 13 experiments
- 10.2-10.6 GeV polarized electrons
- Liquid-hydrogen target
- ~300 mC, ~50% of approved beam time

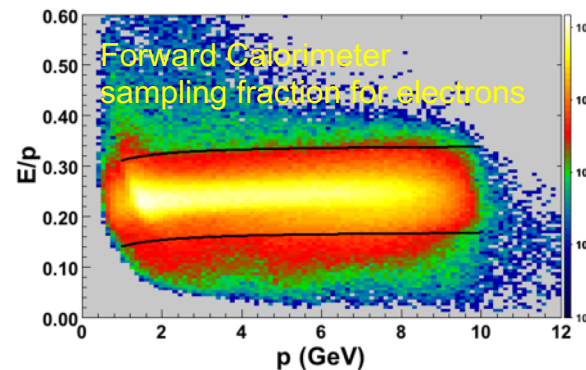
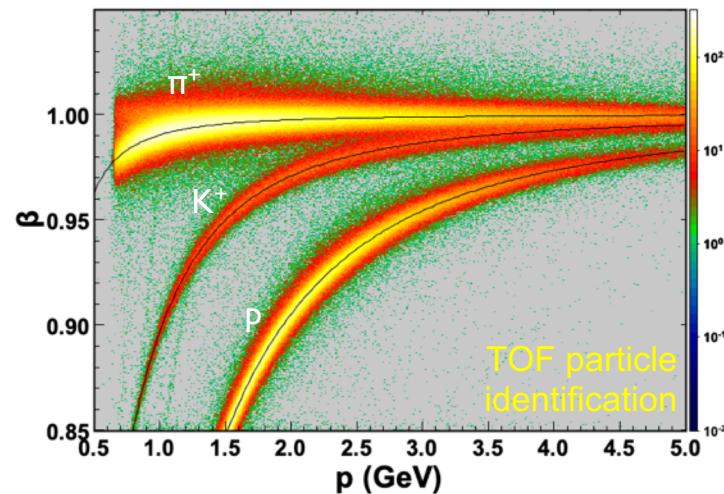
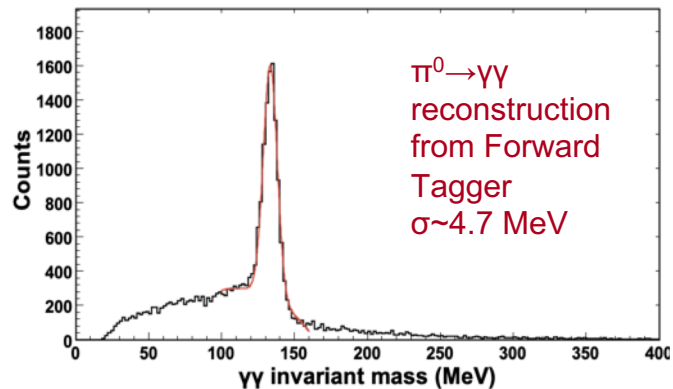
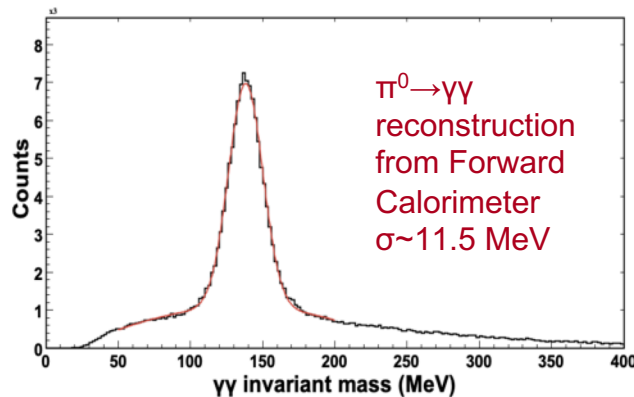
– Run Group K:

- 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
- ~84 mC, ~24% of approved beam time





Run Group Overview and results

RGA: 13 different experiments

SIDIS BSA

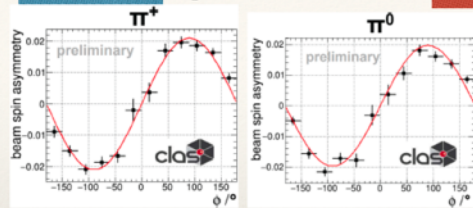
 $pe \rightarrow e'\pi X$

Hall B CLAS12

64 PAC days or 53.5%
of planned data

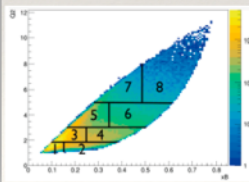
10.6 GeV Polarized Beam

Hydrogen target

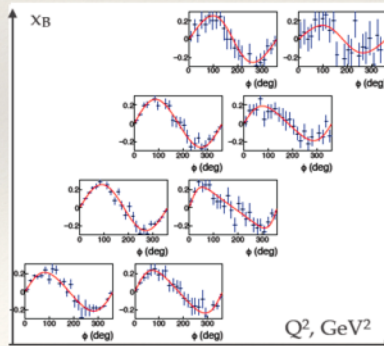


S. Diehl

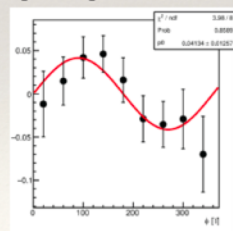
DVCS BSA

 $pe \rightarrow e'\gamma$ 

G. Christiaens



DVMP BSA

 $pe \rightarrow e'p\pi^0$ 

A. Kim

more details during the Collaboration Meeting

from N.Markov presentation at the DNP, Fall 2019

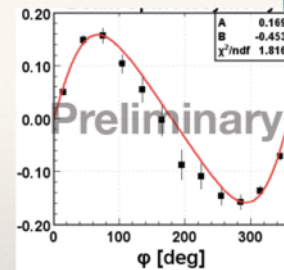
Run Group Overview and results

RGK: 3 different experiments

12.1 PAC days or 12% of planned data

7.5 GeV Polarized Beam

Hydrogen target

 $ep \rightarrow e'\gamma$ 

DVCS BSA

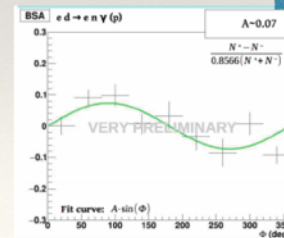
J. Tan

RGB: 7 different experiments

21.8 PAC days or 24% of planned data

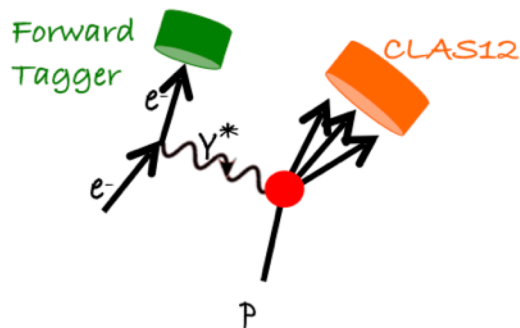
10.2 GeV Polarized Beam

Hydrogen target

 $ed \rightarrow e'\gamma(p)$ 

nDVCS BSA

K. Price

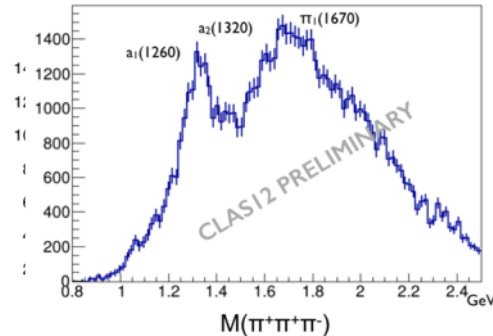


Detailed mapping of the meson spectrum up to masses of 2.5 GeV
 Search for rare or poorly known states (strangeness-rich, scalars, ...)
 Search states with unconventional quark-gluon configurations

CLAS12 $\pi^+\pi^+\pi^-n$ preliminary data

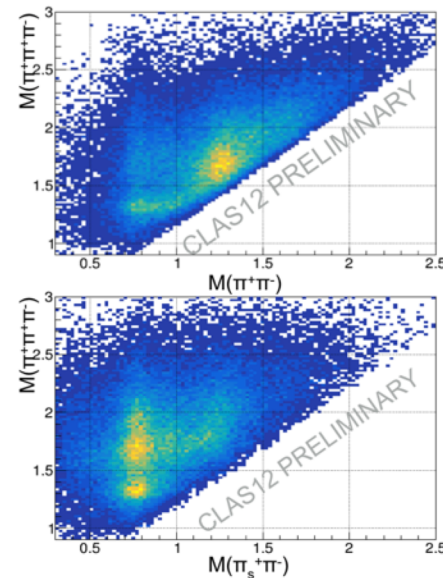
- First analysis of 3 pion channel from the 10.6 GeV data
- Candidate for search of the exotic $\pi_1(1600)$
- Richness spectrum already accessible with few % of the expected data

See talk by M. Battaglia



The CLAS12 Experiment at Jefferson Lab

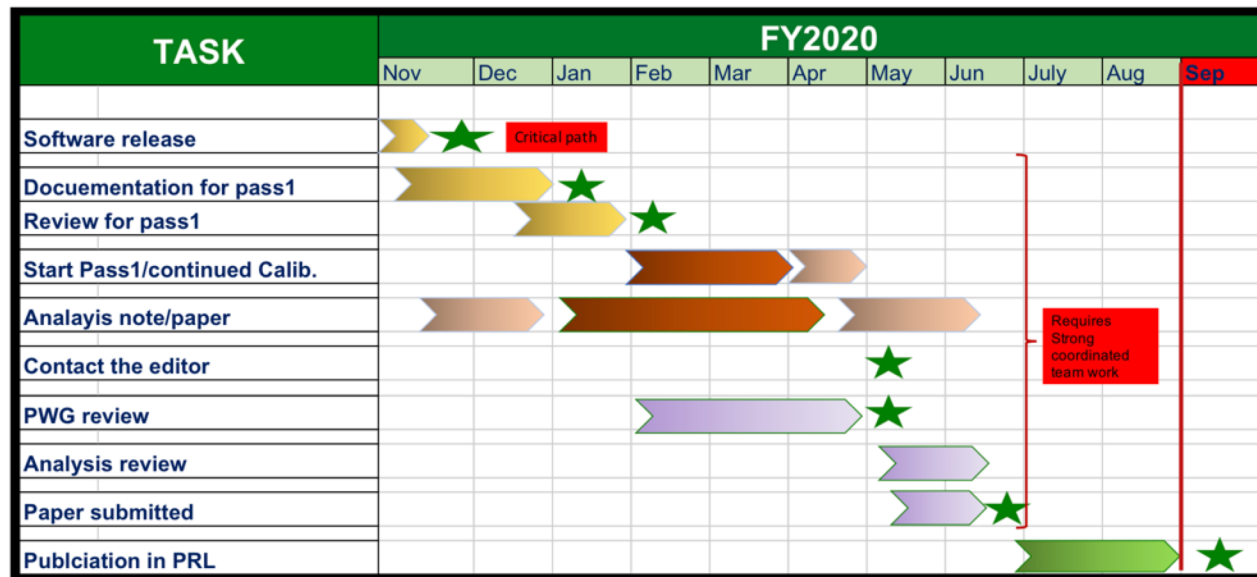
19



D.Glazier results presented by R.De Vita at DNP Fall 2019

Requirements:

- Publication by FY20
- From 12 GeV beam
- Vetted results and cross checked analysis
- Demonstrating the 12GeV & CLAS12 reach
- Science impact
- PRL



The editorial board approved at unanimity the **CLAS12 Special Issue** proposal. We are thrilled to publish it in NIMA journal.

NIM Overview Paper Status

The CLAS12 Spectrometer at Jefferson Laboratory

[illegible]

The CEM3 Leap Acoustic Spectrometer for operation at 10 GHz from range CEM310 at Defense Laboratory is used to study dielectrically loaded surface and bulkwave structures, and provides efficient design of charged and neutral periodic arrays on a large fraction of the full solid angle. CEM310 has been part of the research program of ADRIAN, the Advanced Radar Research Center, Australian Defence Force Research and Development Department of Ranges. A collaboration of over 40 researchers associated to the design and construction of defense hardware, developed the software package for the simulation of complex wave patterns, and manufactured the detector antenna. CEM310 is based on a dual-scan geometry with a mechanically scanned feed horn and a planar antenna array. The feed horn is steered by a 2D piezoelectric stage, and a solenoid magnet and detector covering the polar angles from 0° to 120° , with full azimuthal coverage. Trajectory measurements in the forward direction using drift chambers and in the central down-scan using a wire target result in measurement accuracies of ± 0.5 mrad, ± 0.5 deg, respectively. Characterization of the antenna array is done using a planar waveguide with a 1000 element linear array. Data taken at 10 GHz suggest high data-acquisition rates allow operation at a bandwidth of 10^6 Hz m^{-2} . The capabilities are being used in a broad program to study the structure and interactions of antennas, such as arrays, in planar and curved geometries. Beam and targets for beam scans are used to test the accuracy of the beam direction of the device. *Keywords:* antennas, radar, waveguides, m^{-2} Hz.

Electric scattering has been proven as effective way of probing the size and internal structure of submicron particles in protein, vesicles, and nuclei. Exploiting magnetic resonance leads to the development of a new generation of probes and sequences of particles. The extended size of the protein was first suggested by its α -helix (2), and later by the β -sheet (3). In the late 1970s (4–6) using spin-polarized electrons and spin-polarized targets, the internal-quick motion of the protein was investigated. In the 1980s and the following years, it was still an important research topic today (7). These experiments only required additional accessories, such as the spin-polarized electron source, that is, a magnet adjoined to a electron

scattering apparatus.

In the decades following these discoveries, it is realized that a more detailed understanding of the internal structure of molecules requires the measurement of the internal structure of the molecule, and hence the detection and kinematic reconstruction of additional neutrons and baryons in the final state. This is the so-called "neutron tagging" from the desire of baryon spectroscopy to measure complete angular distributions, which made it a very important research topic in the 1980s and 1990s (8). The first experiment in electron beam induced proton decay (EBCPD) was performed by the SLAC detector, and other experiments reported at JLab (9) and Jefferson Lab (10) were also carried out.

Project submitted to *Review*

(article in this issue)

Outline:

1. Introduction
2. The JLab Facility at 12 GeV
3. The CLAS12 System
4. CLAS12 Central Detector
5. CLAS12 Offline Software
6. CLAS12 Operational Performance
7. Data Acquisition and Trigger System
8. Electron Beam Operation
9. Summary

Review Status:

Initial review in progress

Remaining Work to Completion:

1. Finalize authors list
2. Include graphs/info from subsystems
3. Update performance graphs with improved calibrations
4. Fill summary table with up-to-date numbers

Status of CLAS12 NIM Papers – 11/5/19

System	Lead	% Comp	Pages	Rev. 1	Fig. Rev.	Reviewer	Rev. 2	Status Update
SVT	Gotra/Elouadrhiri	100	38	✓	✓	Alexander Sukhanov, FNAL	in prog.	Rev. 2 in progress
MVT	Bossu/Defurne	100	14	✓	in prog.	Sebastian Kuhn, ODU	in prog.	Rev. 2 in progress
CTOF	Carman	100	26	✓	✓	Brian Raue, FIU	✓	Done
CND	Niccolai	100	12	✓	✓	Cole Smith, JLab	in prog.	Rev. 2 in progress
HTCC	Sharabian	100	34	✓	in prog.	Stepan Stepanyan, JLab	in prog.	Rev. 1 underway
DC	Mestayer	100	26	✓	in prog.	Simon Taylor, JLab	in prog.	Rev. 1 underway
LTCC	Ungaro	90	21	TBD	TBD	Youri Sharabian, JLab		finalizing draft
RICH	Rossi/Contalbrigo	75	11	TBD	TBD	Xiaochun He, GSU		working on initial draft
FTOF	Carman	100	26	✓	✓	Beni Zihlmann, JLab	✓	Done
ECAL	Smith/Stepanyan	100	17	✓	in prog.	Andrea Celentano, INFN	in prog.	Rev. 2 in progress
FT	Battaglieri/De Vita	75	20	TBD	TBD	Tanja Horn, CUA		finalizing draft
Beamline	Stepanyan/Raue	100	13	✓	✓	Eugene Pasyuk, JLab	✓	Done
DAQ	Boyarinov	100	22	✓	in prog.	Alexander Somov, JLab	in prog.	Rev. 2 in progress
Trigger	Kubarovsky	100	26	✓	in prog.	Graham Heyes, JLab	in prog.	Rev. 2 in progress
Sim	Ungaro	100	28	✓	✓	Will Brooks, UCSM	in prog.	Rev. 2 in progress
Recon	Ziegler/De Vita	75	25	TBD	TBD	David Lawrence, JLab		working on initial draft
Magnets	Fair	100	33	✓	✓	GianLuca Sabbi, LBL	in prog.	Rev. 2 in progress
Overview	Burkert/Elouadrhiri	100	33	in prog.		Elton Smith, JLab		Rev. 1 underway
OVERALL		95.6%	426					

NIM status assessment review in October boosted the process

All papers completed by Nov 11

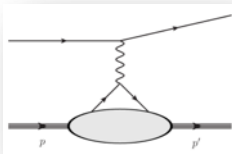
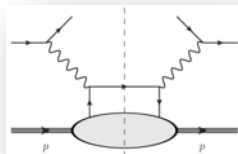
All final review by Nov 26

All papers and reviews completed by Dec 16

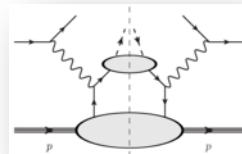
Submission to NIM from Dec 1 to Dec 20

Repository:

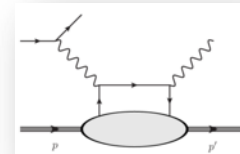
<https://github.com/JeffersonLab/clas12Nim>

Elastic
Scattering

DIS



SIDIS



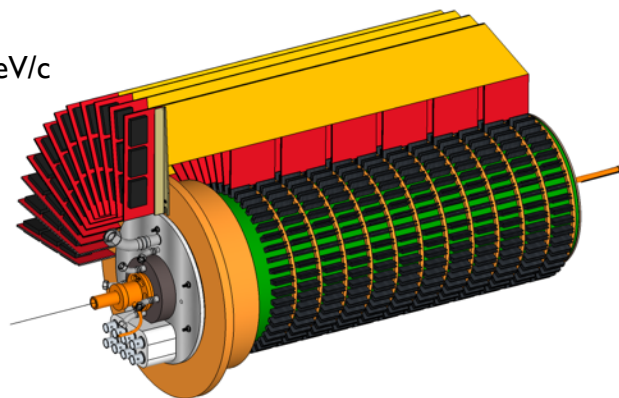
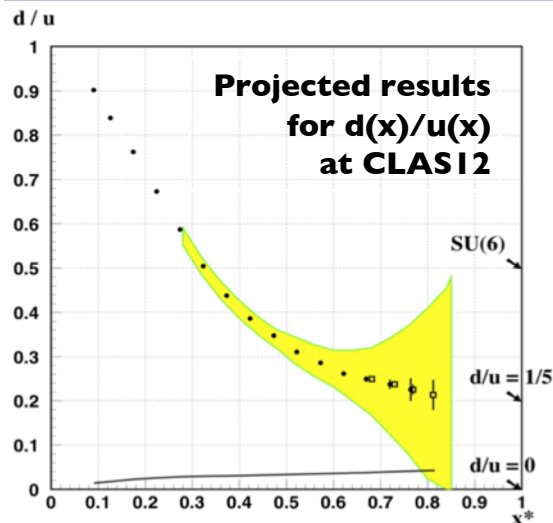
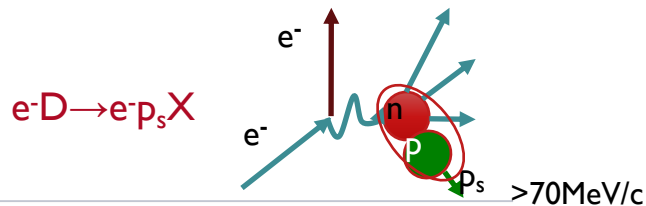
DVCS

+ J/psi photoproduction & SRC

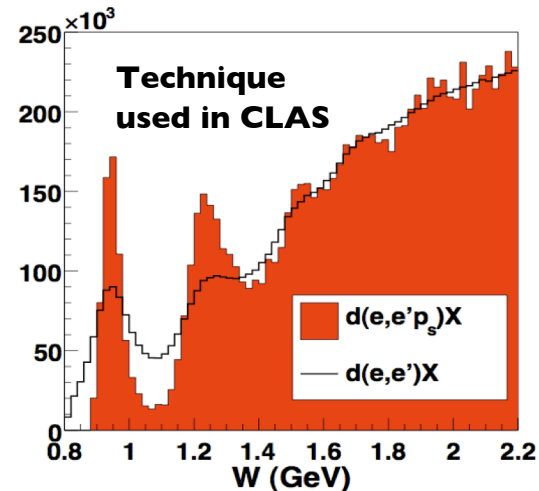
	Physics	Contact	Rating	Days	% complete	comment
E12-07-104	Neutron magnetic form factor	Gilfoyle	A-	30	72.7	
E12-09-007(a)	Study of partonic distributions in SIDIS kaon production	Hafidi	A-	30	36.3	2 LTCC, 1 RICH
E12-09-008	Boer-Mulders asymmetry in K SIDIS w/ H and D targets	Contalbrigo	A-	30	36.3	2 LTCC, 1 RICH
E12-09-008B	Collinear nucleon structure at twist-3	Mirazita	NR	(56)	38.9	
E12-11-003	DVCS on neutron target	Niccolai	A	90	24.2	
E12-11-003A	In medium structure functions, SRC, and the EMC effect	Hen	NR	(90)	24.2	
E12-003B	J/Psi production on deuterium	Ilieva pentaquark J/Psi	NR	(80)	5.5 *) 8.3	Suffers from low energy
RG-B completion				21.8	24.2	

*) Entries are weighted with factor less than 1 to account for reduced beam energy during part of the run.

F_2^n/F_2^p ratio by tagging almost unbound neutrons using detection of low momentum protons in a radial TPC



Scheduled from Feb 12 to May 1st (+5 days contingency) = 80/2 PAC days



Proposed schedule

Acc ops expected to resume in Jan-21 after a long shutdown for the ColdBox replacement

Assume 30 weeks operations split between Spring/Fall runs

Assume to restart at 5 passes (11 GeV)

8/10 weeks RG-D/E (~50% PAC days allocated) - nuclear targets - Color transparency + hadronization

6/8 weeks RG-M - neutrino's and SRC in nuclei

May be difficult due to the several configuration changes (several combination of E_{beam} and target)

Summer 2021: NH3/ND3 installation (~2 months)

Fall 2021 (10/12 weeks): ~30% of RG-C completed

Meet on Wed with RG representatives

Discuss the schedule with the CCC

Back to the Lab Scheduling Committee

Summary/Outlook

Continuous flow of publications from CLAS6 and PRad (Nature)

During summer, HPS collected 60% of the expected statistics at 4.5 GeV

Continuous progress of the CLAS12 common analysis framework and data processing

RG-A, RG-B and RG-K first results presented at the DNP 2019 in DC

CLAS12 NIM publication almost ready (expected submission in December 2021)

Proposed a strategy for the CLAS12 first publication

RG-B (II part) and BONUS ready to run in Fall 2019 / Spring 2020

Nuclear target test scheduled for late January 2020

Preliminary draft of FY21 schedule includes nuclear target runs (RG-D/E and RG-M) and NH3/ND3

Thank you, Volker, for the
outstanding scientific
achievements and the inspiring



... it is not easy to fill such big shoes but Volker
formed an incredible team I can count on ...

