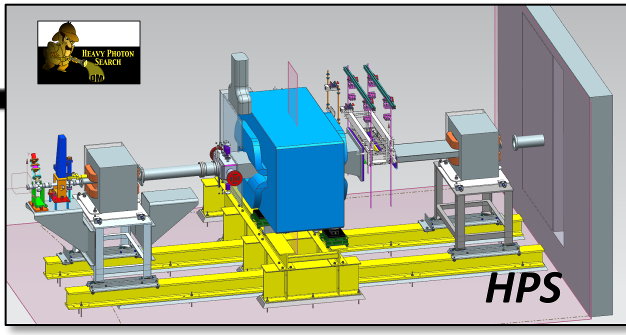
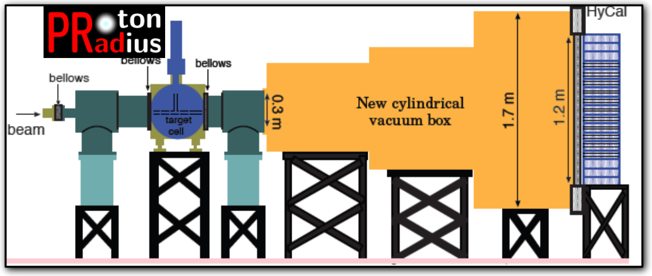
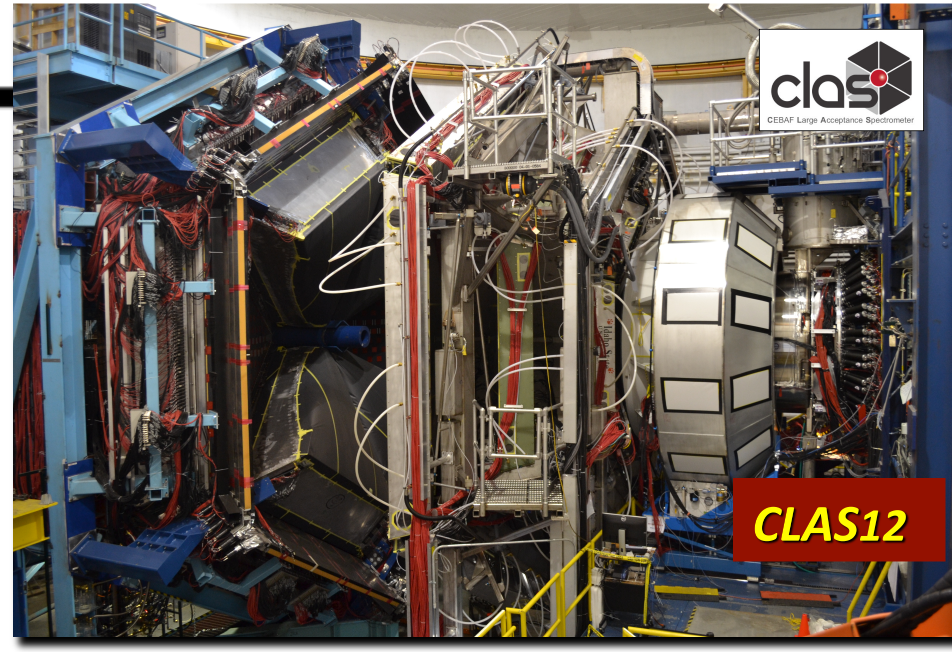






Status of Hall B

Volker D. Burkert
Jefferson Lab

PAC46 Meeting 07/16/2018

- Hall B Publications & impact
- CLAS12 status
  - Spring 2018 run
  - Preliminary data
- Future run groups
- Summary

Evidence for Nucleon & Delta States

Multiple nucleon resonances now confirmed; highlighted in Particle Data Group (PDG) tables.

State N((mass)J^P	RPP 2008	RPP 2018
N(1710)$1/2^+$	***	****
N(1880)$1/2^+$		***
N(2100)$1/2^+$	*	***
N(1895)$1/2^-$		****
N(1900)$3/2^+$	**	****
N(1875)$3/2^-$		***
N(2120)$3/2^-$		***
N(2060)$5/2^-$		***
Δ(1900)1/2-	**	***
Δ(2200)7/2-	*	***

Obtaining an accurate account of the nucleon resonance spectrum is essential for connecting QCD to the light quark sector.

Tremendous progress in solving the "Missing Resonances" problem in employing PWA to high precision data

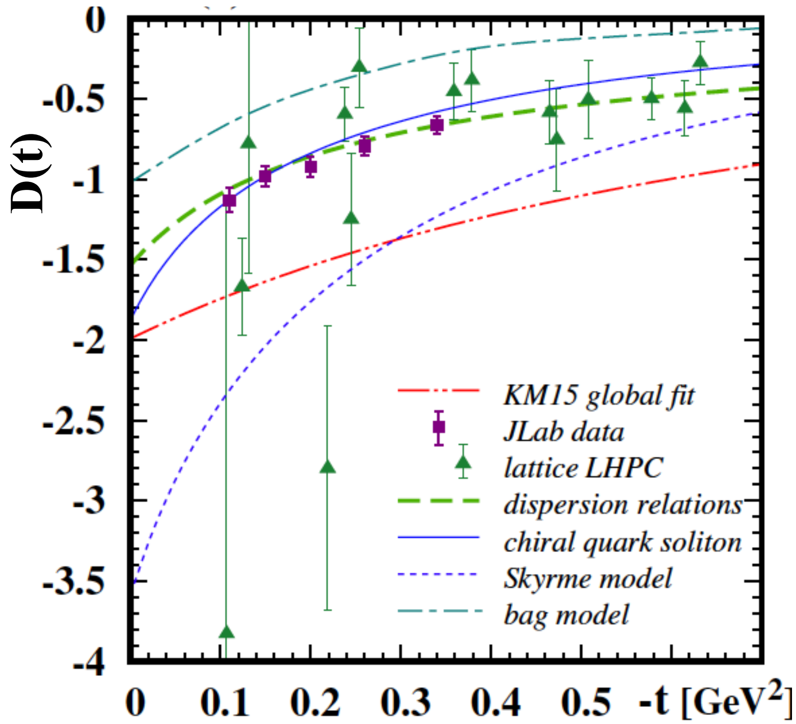
Also electroproduction transition form factors included in N* & Δ review.
http://pdg.lbl.gov/2018/reviews/rpp2018-rev-n-delta-resonances.pdf

****	Existence is certain
***	Existence is very likely
**	Evidence of existence is fair
*	Evidence of existence is poor

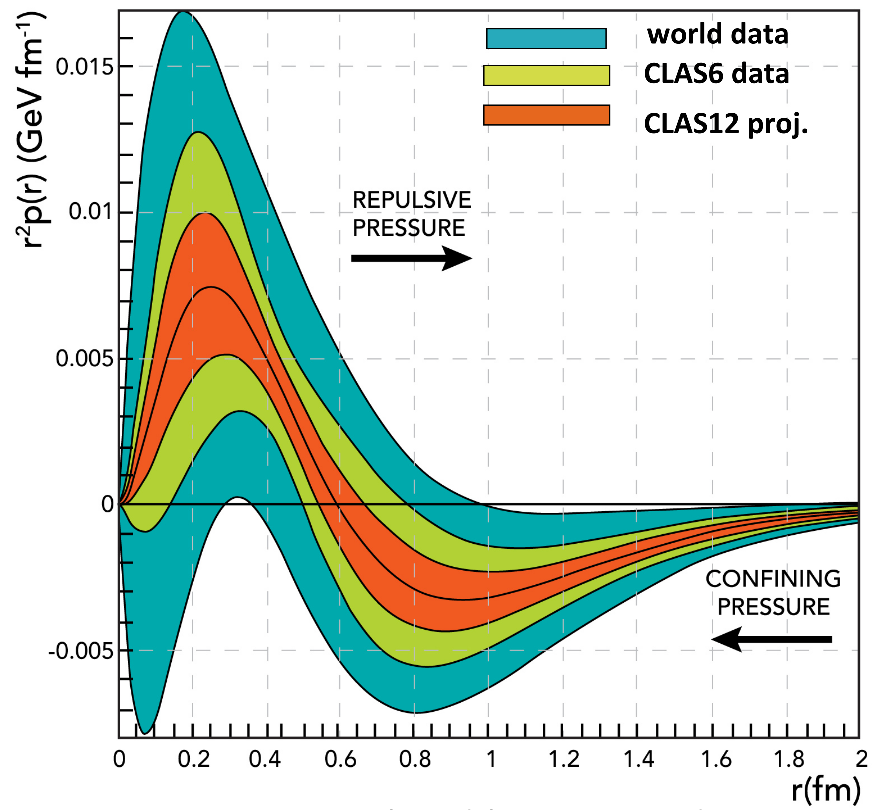
First gravitational FF of the proton

nature
International weekly journal of science

From CLAS DVCS-BH beam spin asymmetry.
First determination of basic proton property.



$$d_1(t) \propto \int \mathrm{d}^3\mathrm{r}\, \frac{j_0(r\sqrt{-t})}{2t}\, p(r)$$

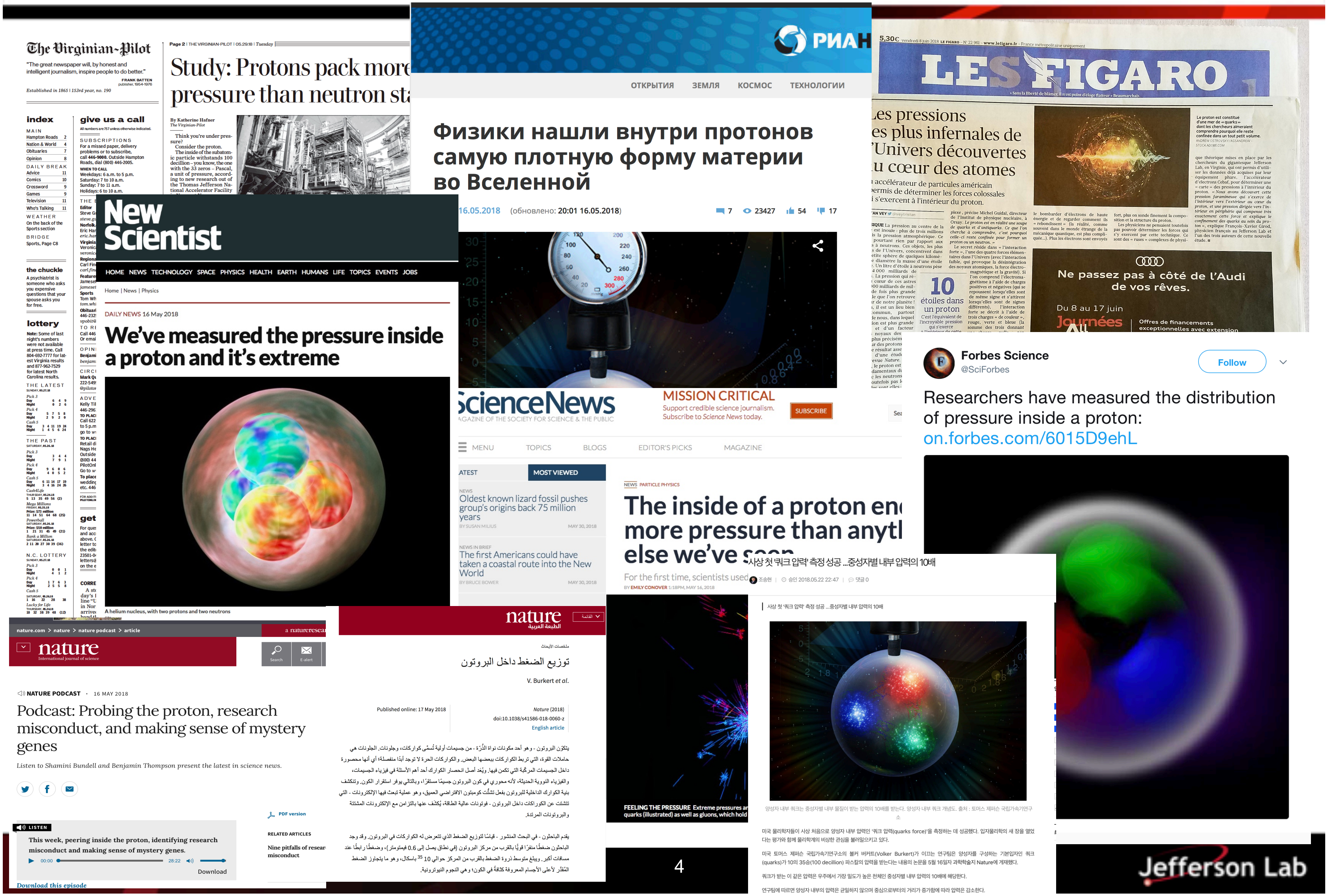


V.B., L. Elouadrhiri, F.X. Girod, Nature 557 (2018) 7705, 396

PAC44 approved 12 GeV program
E12-16-10B

The beginning of a new direction in nuclear and hadronic physics.

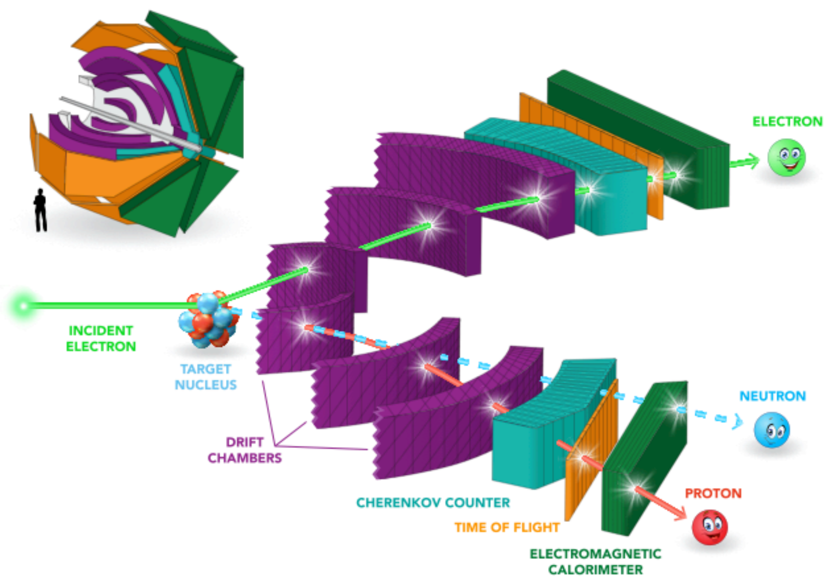
In the News May/June 2018

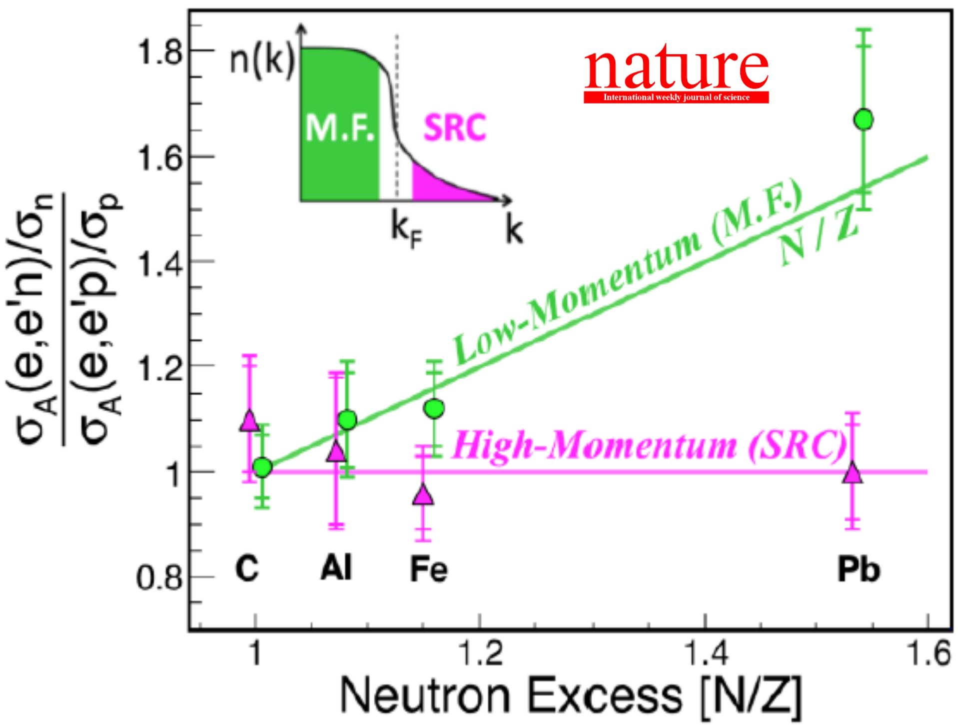


Abundance of hi/lo momentum protons/neutrons

EG2/Data Mining

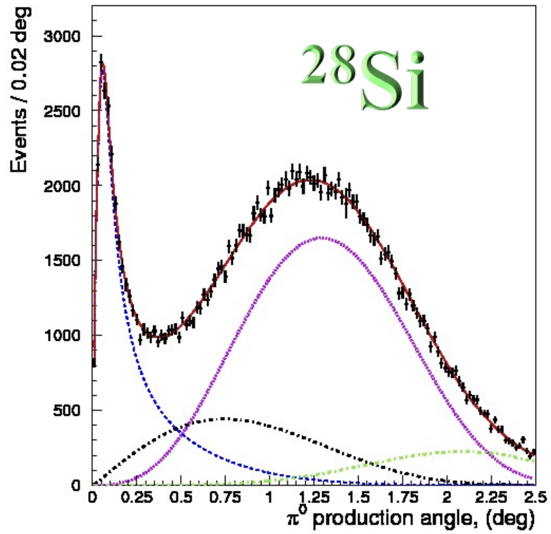
M. Duer et al. (accepted in Nature)

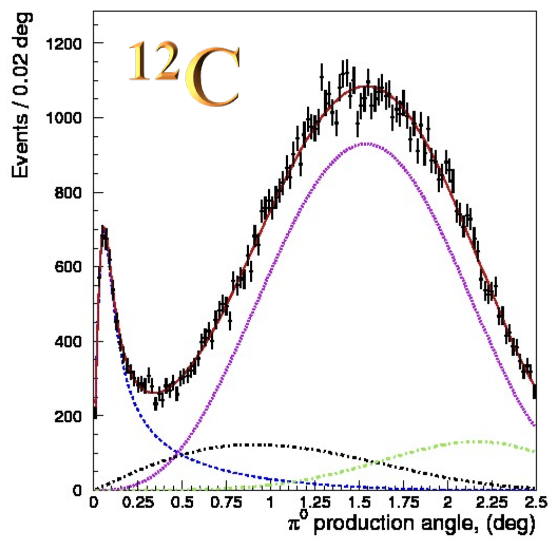




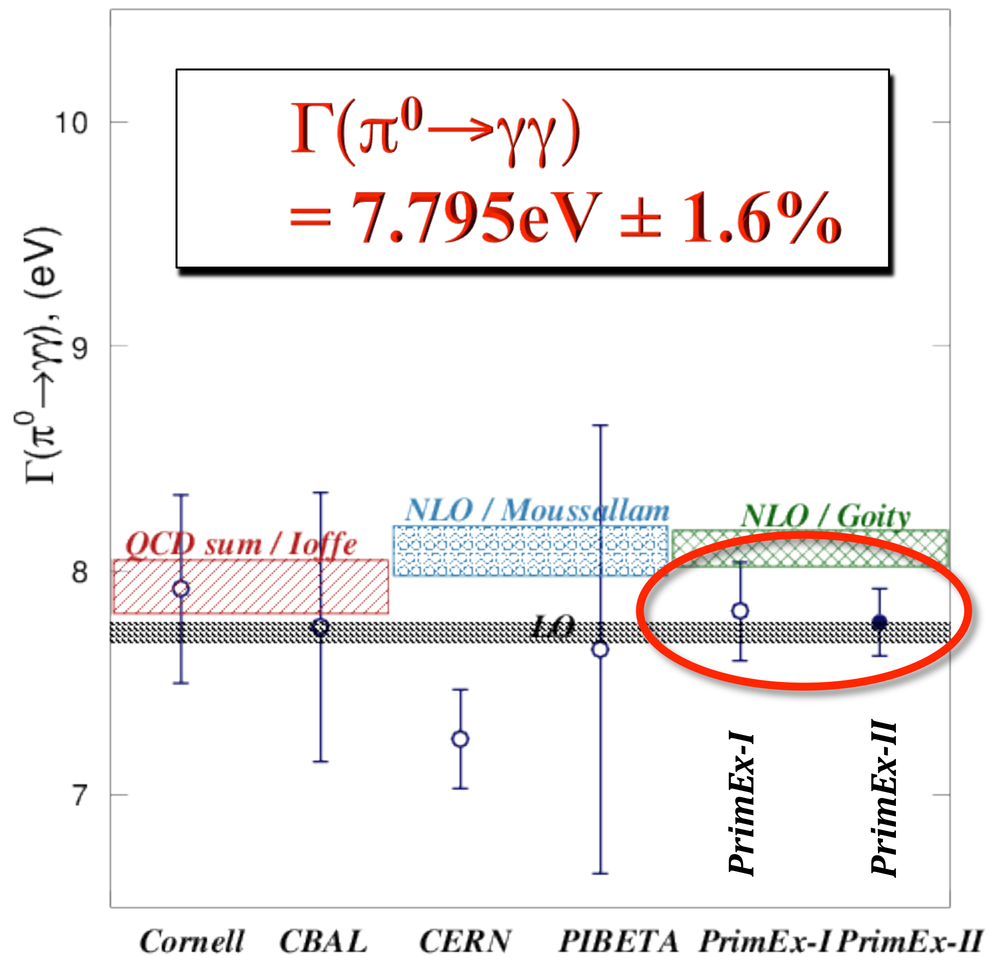
Ratio of neutron/proton abundances ~ independent of neutron excess in SRC
~ linearly rising for M.F. nucleons.

PrimEx-II results



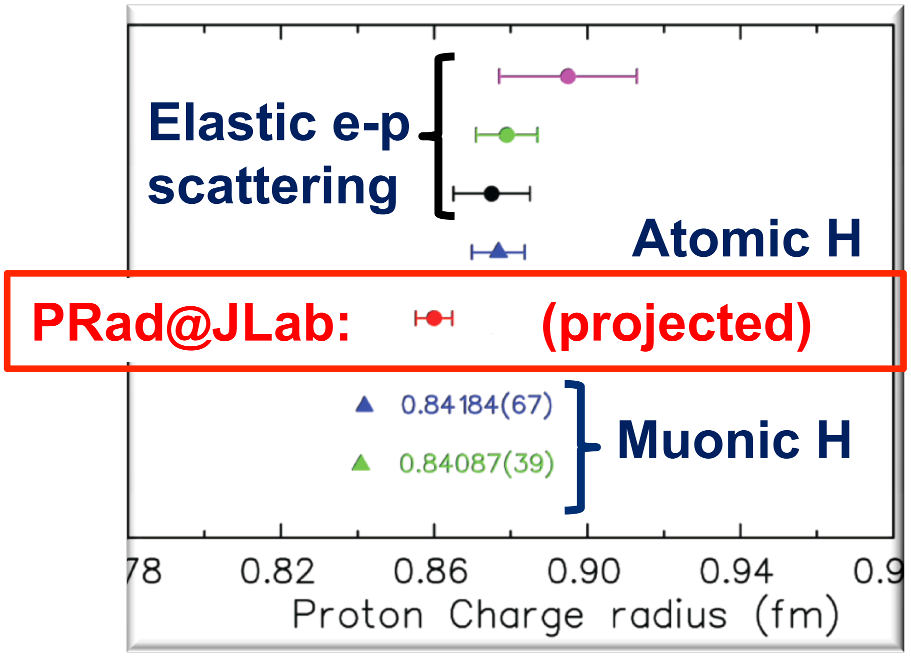


Primakoff measurements of $\Gamma(\pi^0 \to \gamma\gamma)$

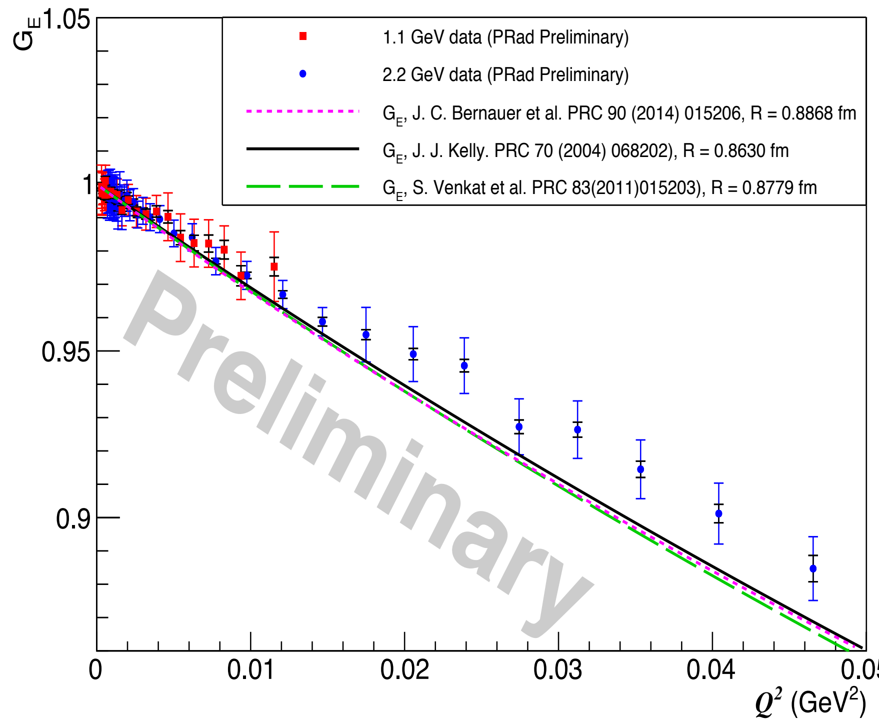


Proton Radius Experiment

Experiment ran in 2016



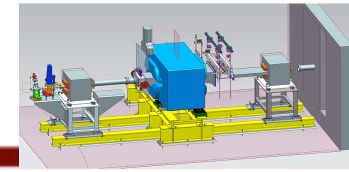
Proton Electric Form Factor G_E



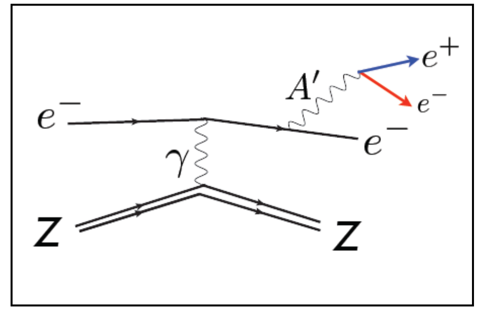
Goal: Resolve the discrepancy with non-magnetic detection system, higher precision and lowest min. Q^2

Preliminary G_E slope seems to favor smaller radius

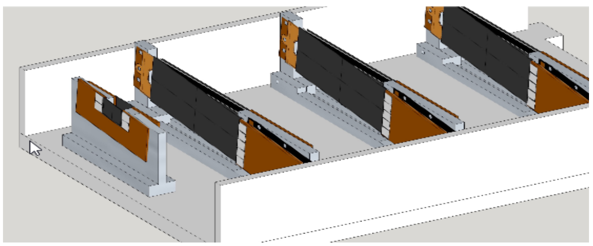
Heavy Photon Search (A’)



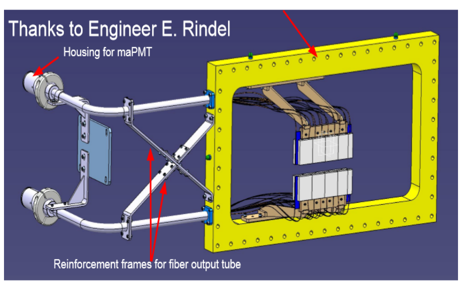
The final bump hunt results from 2015 are close to publication. 2016 Bump hunt and vertex search analyses are under way.

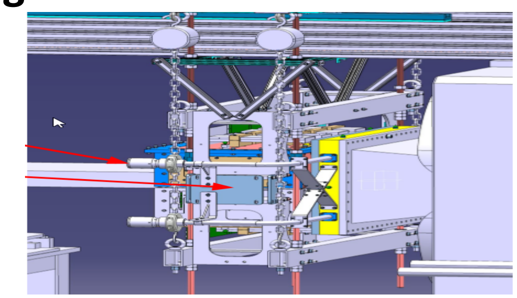


- **HPS upgrades ready for 2019 running.**



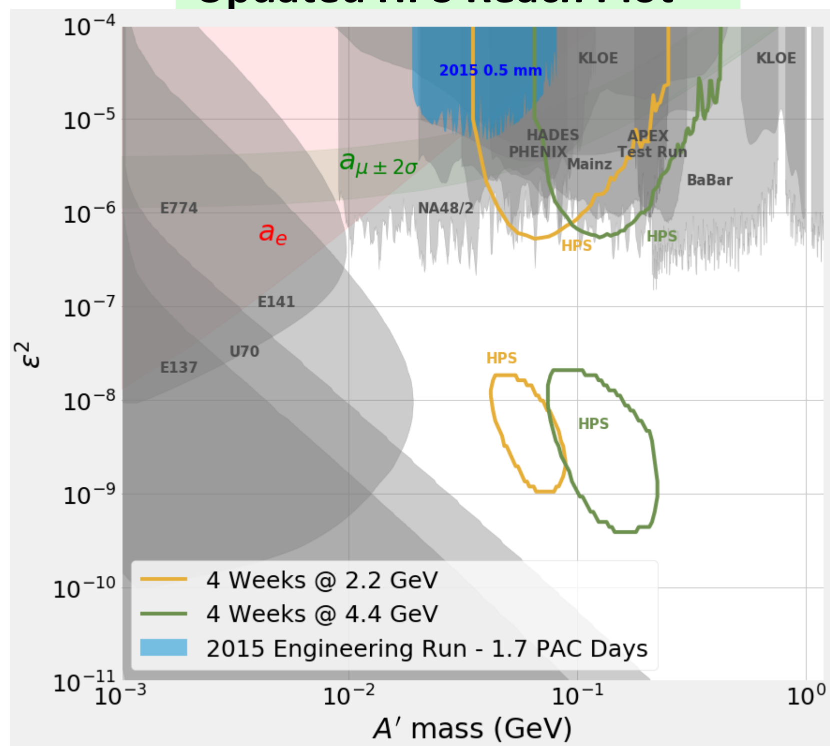
- **New Positron Trigger will double e^+e^- pairs yield and reduce backgrounds.**





- **HPS will resume A’ search in well-motivated, unexplored parameter space in 2019**

Updated HPS Reach Plot

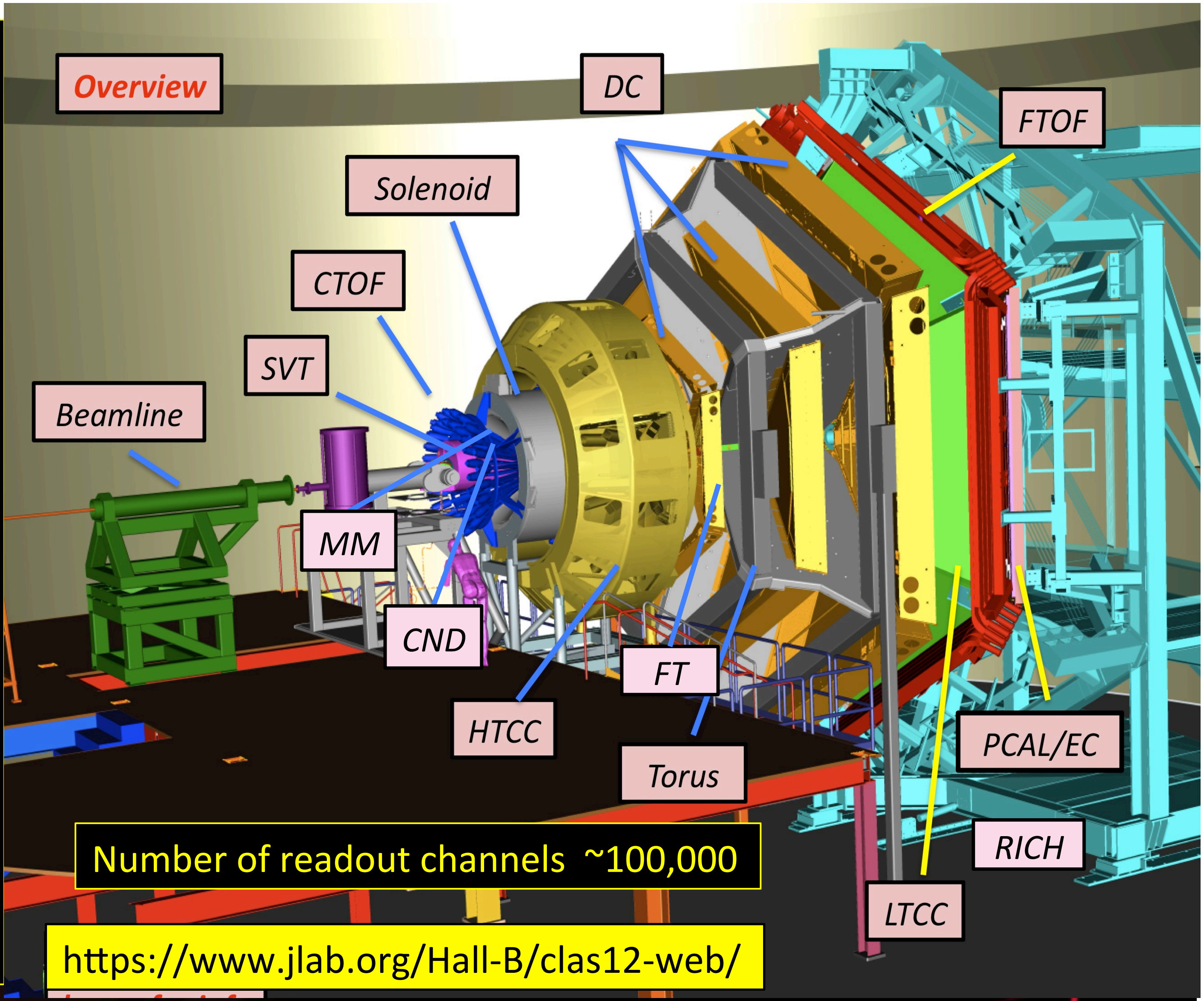


CLAS12 **Detector Systems**

Forward Detector (FD)
- TORUS magnet
- HT Cherenkov Counter
- Drift chamber system
- LT Cherenkov Counter
- Forward ToF System
- Pre-shower calorimeter
- E.M. calorimeter
- Forward Tagger
- RICH detector

Central Detector (CD)
- Solenoid magnet
- Silicon Vertex Tracker
- Central Time-of-Flight
- Central Neutron Detector
- MicroMegas

Beamline
- Photon Tagger Dump
- Shielding
- Targets
- Moller Polarimeter
- Faraday Cup

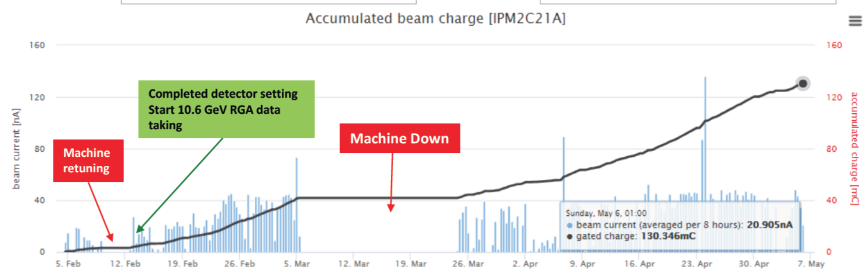


Number of readout channels ~100,000

https://www.jlab.org/Hall-B/clas12-web/

RG-A 2018 Spring Run

start date: 02/05/2018 end date: 05/06/2018



118mCb collected charge of high luminosity

At L = $10^{35}cm^{-2}s^{-1}$ this corresponds to: 18.2 PAC days

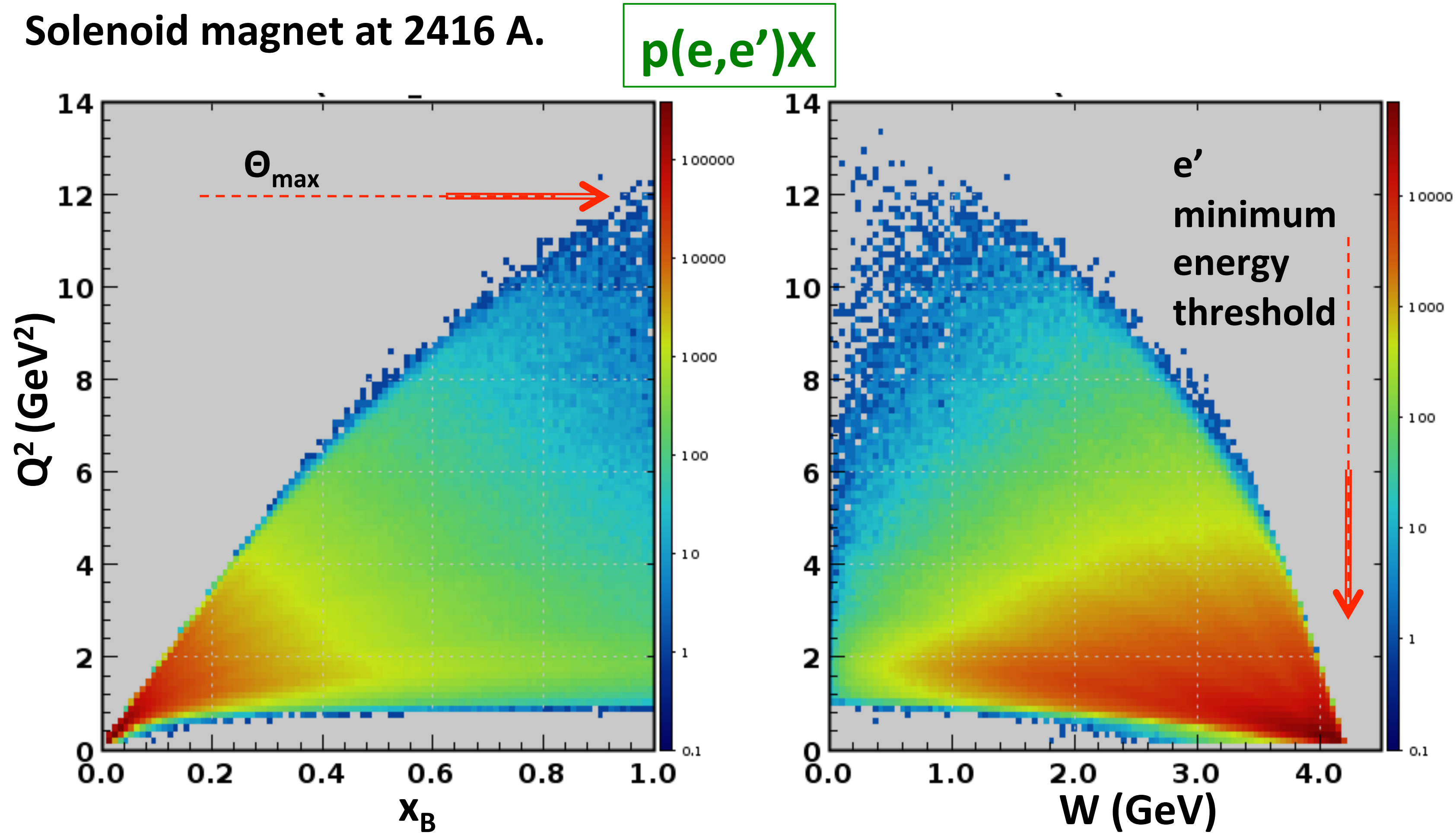
Low luminosity for 7 scheduled days: 3.5 PAC days

Total: 21.7 PAC days

Proposal	Physics	Contact	Rating	Days	% complete	comment
E12-06-108	Hard exclusive electro-production of π^0, η	Stoler	B	80	**24**	
E12-06-108A	Exclusive N*->KY Studies with CLAS12	Carman	NR	(60)	**35**	
E12-06-108B	Transition Form Factor of the η' Meson with CLAS12	Kunkel	NR	(80)	**24**	
E12-06-112	Proton's quark dynamics in SIDIS pion production	Avakian	A	60	**11**	1 LTCC, 1 RICH
E12-06-112A	SIDIS Λ productiuon in target fragmentation region	Mirazita	NR	(60)	**11**	1 LTCC, 1 RICH
E12-06-112B	Colinear nucleon structure at twist-3	Pisano	NR	(60)	**11**	1 LTCC, 1 RICH
E12-06-119(a)	Deeply Virtual Compton Scattering	Sabatie	A	80	**24**	
E12-09-003	Excitation of nucleon resonances at high Q^2	Gothe	B+	40	**48**	
E12-11-005	Hadron spectroscopy with forward tagger	Battaglieri	A-	119	**19**	
E12-11-005A	Photoproduction of the very strangest baryon	Guo	NR	(120)	**19**	
E12-12-001	Timelike Compton Scatt. & J/ψ production in e+e	Nadel-Turonski	A-	120	**19**	
E12-12-001A	J/ψ Photoproduction & study of LHCb pentaquarks	Stepanyan	NR	(120)	**19**	
E12-12-007	Exclusive φ meson electroproduction with CLAS12	Girod	B+	60	**31**	
				Average completion (%)	**22.7**	

Kinematic reach

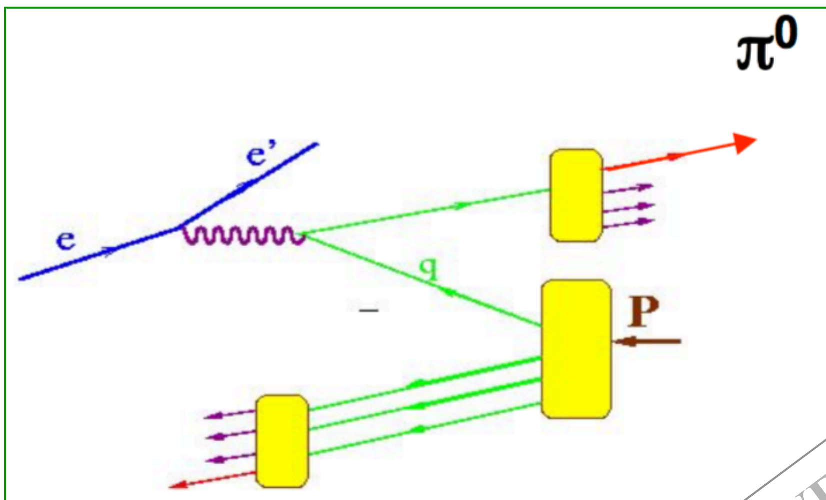
Beam energy at 10.6 GeV Torus current 3770 A, electrons out-bending, Solenoid magnet at 2416 A.

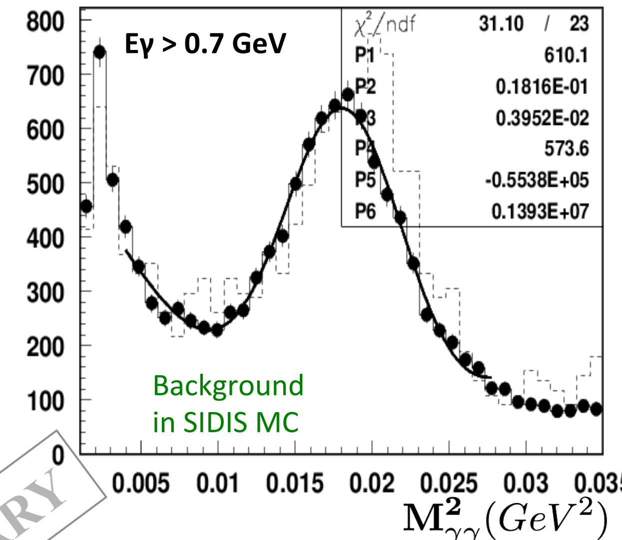


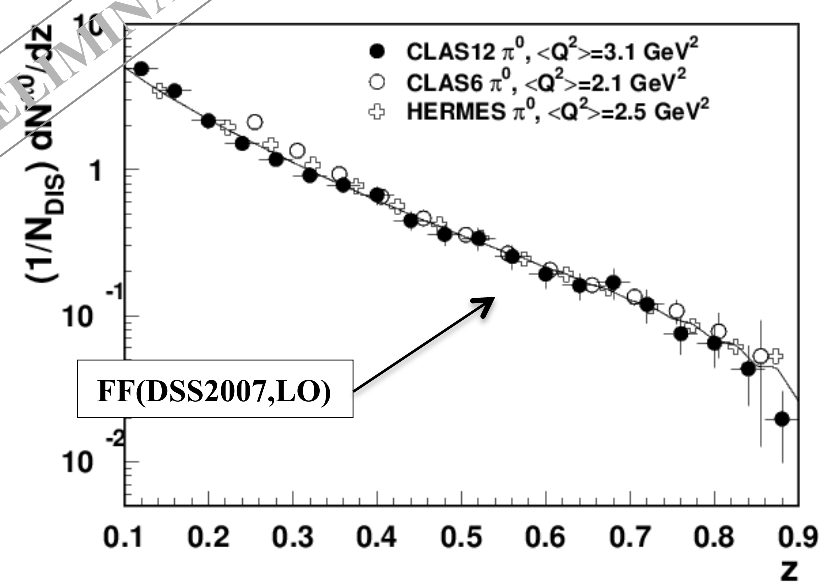
CLAS12 First SIDIS results $e'\pi^0X$

Extraction of $e'\pi^0X$/ e'X ratio (ratio of semi-inclusive pi0 to inclusive electron) requires good control over the acceptance of photons.

~0.5% of spring 10.6 GeV data.







At large x, when sea contribution can be neglected $e'\pi^0X$/ e'X should follow the z-dependence of the fragmentation function (after integration over P_T)

Hall B 12 GeV Publication Schedule

• Heavy Photon Search (HPS)	2015 data - expect in one month 2016 data - end of 2019
• Proton Radius (PRAD)	End of 2018
• RG-A (13 proposals)	Release first results at DNP 2019 First publication after that.

Future Run Groups

- **RG-A (RG-K) -** to continue this fall until end of 2018

- **RG-B** - scheduled to run during the spring and the fall of 2019
  - Liquid deuterium target
  - BAND detector for backward angle neutron detection

- **HPS** - scheduled to run summer of 2019 with upgraded detector and trigger system

- **BONuS12** - projected to run spring/fall of 2020
  - A new low energy recoil detector based on GEM technology, to replace SVT

- **RG-C -** Polarized target for CLAS12 - on track for installation to support spin program in 2020/21

Summary

- Continuous flow of data from CLAS lead to discovery of new baryon states and first insight into the nucleon gravitational properties.

- The data mining initiative has been very successful leading to several publications, including publication in Science and Nature Journals.

- Several dedicated experiments addressing fundamental properties of hadrons (π^0 LT, proton charge radius) and search for the messengers of dark matter.

- CLAS12 had successful first production run achieving projected luminosity and providing data for 13 individual proposals.

- Data runs after 2018 focus of neutron structure properties RG-B (7 experiments), HPS, BoNuS12, and spin physics with RG-C (6 experiments).

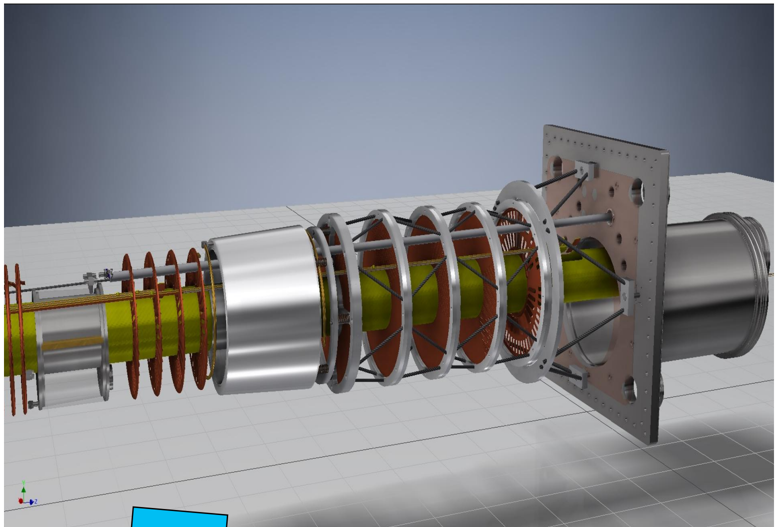
Run Groups

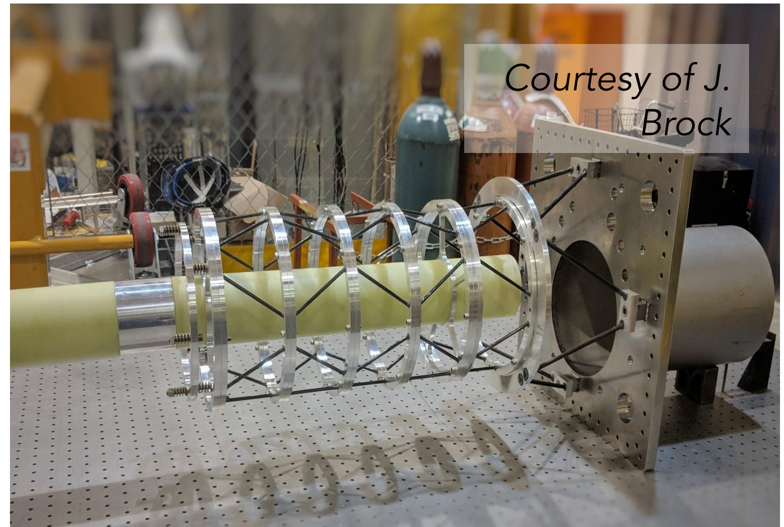
HALL B

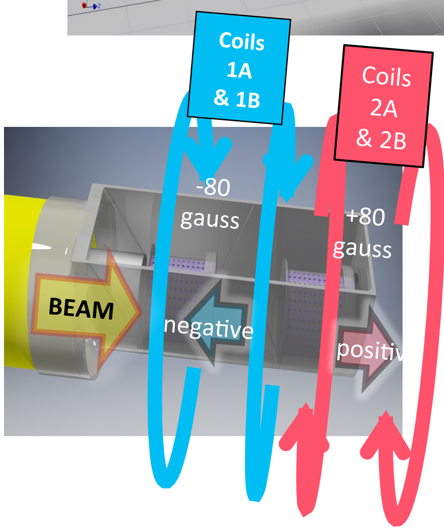
Proposal	Physics	Contact	Rating	Days	Group	Equipment	Energy	Run Group	Target
E12-06-108	Hard exclusive electro-production of π^0, η	Stoler	B	80	139	RICH (1 sector) Forward tagger	11	**A** F. Sabatié	liquid H_2
E12-06-108A	Exclusive N*->KY Studies with CLAS12	Carman		(60)					
E12-06-108B	Transition Form Factor of the η' Meson with CLAS12	Kunkel		(80)					
E12-06-112	Proton's quark dynamics in SIDIS pion production	Avakian	A	60					
E12-06-112A	SIDIS Λ productiuon in target fragmentation region	Mirazita		(60)					
E12-06-112B	Colinear nucleon structure at twist-3	Pisano		(60)					
E12-06-119(a)	Deeply Virtual Compton Scattering	Sabatie	A	80					
E12-09-003	Excitation of nucleon resonances at high Q^2	Gothe	B+	40					
E12-11-005	Hadron spectroscopy with forward tagger	Battaglieri	A-	119					
E12-11-005A	Photoproduction of the very strangest baryon	Guo		(120)					
E12-12-001	Timelike Compton Scatt. & J/ψ production in e+e	Nadel-Turonski	A-	120					
E12-12-001A	J/ψ Photoproduction & study of LHCb pentaquarks	Stepanyan		(120)					
E12-12-007	Exclusive φ meson electroproduction with CLAS12	Girod	B+	60					
E12-07-104	Neutron magnetic form factor	Gilfoyle	A-	30	90	Neutron detector RICH (1 sector) Forward tagger	11	**B** S. Niccolai	liquid D_2 target
E12-09-007(a)	Study of partonic distributions in SIDIS kaon production	Hafidi	A-	30					
E12-09-008	Boer-Mulders asymmetry in K SIDIS w/ H and D targets	Contalbrigo	A-	56					
E12-09-008A	Hadron production in target fragmentation region	Mirazita		(60)					
E12-09-008B	Colinear nucleon structuer at twist-3	Pisano		(60)					
E12-11-003	DVCS on neutron target	Niccolai	A	90					
E12-11-003A	In medium structure functions, SRC, and the EMC effect	Hen		(90)					
E12-11-003B	J/Psi Photoproduction off the Deuteron	Ilieva		(80)					
Beam time partial sum				**765 (1475)**	**229**				

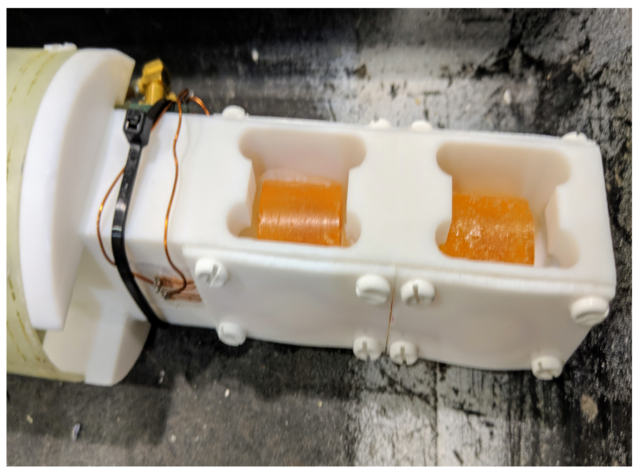
CLAS12

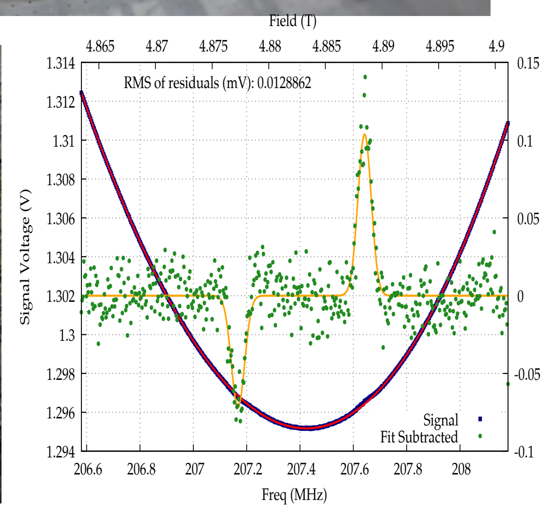
Longitudinally Polarized Target









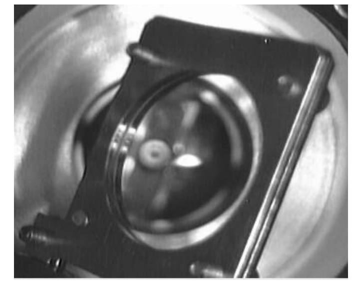


Construction of the 1K refrigerator anticipated completion date: Sept. 30, 2018

e+HD studies at the UITF – a prelude to e+$\vec{H}_{transverse}$

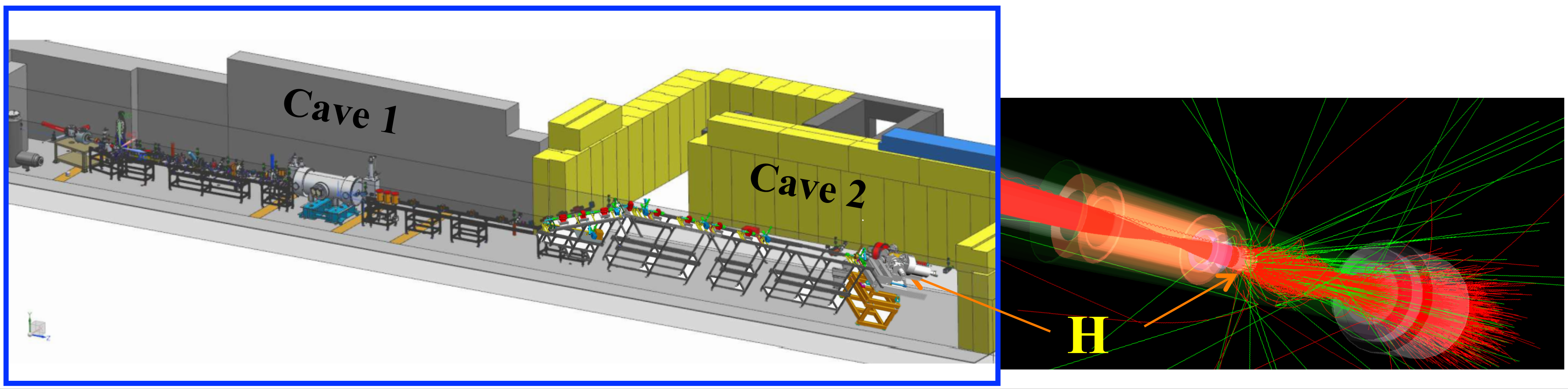
UITF ⇔ 10 MeV accelerator in the *TestLab*

- *energy deposition in HD ~ as with 10 GeV ⇔ testbed for transverse e+HD*
- *keV beams in cave 1 in Dec/17 ✓*
- *¼ CM cooled in Apr/18 ✓*
- *PSS-RadCon under construction*



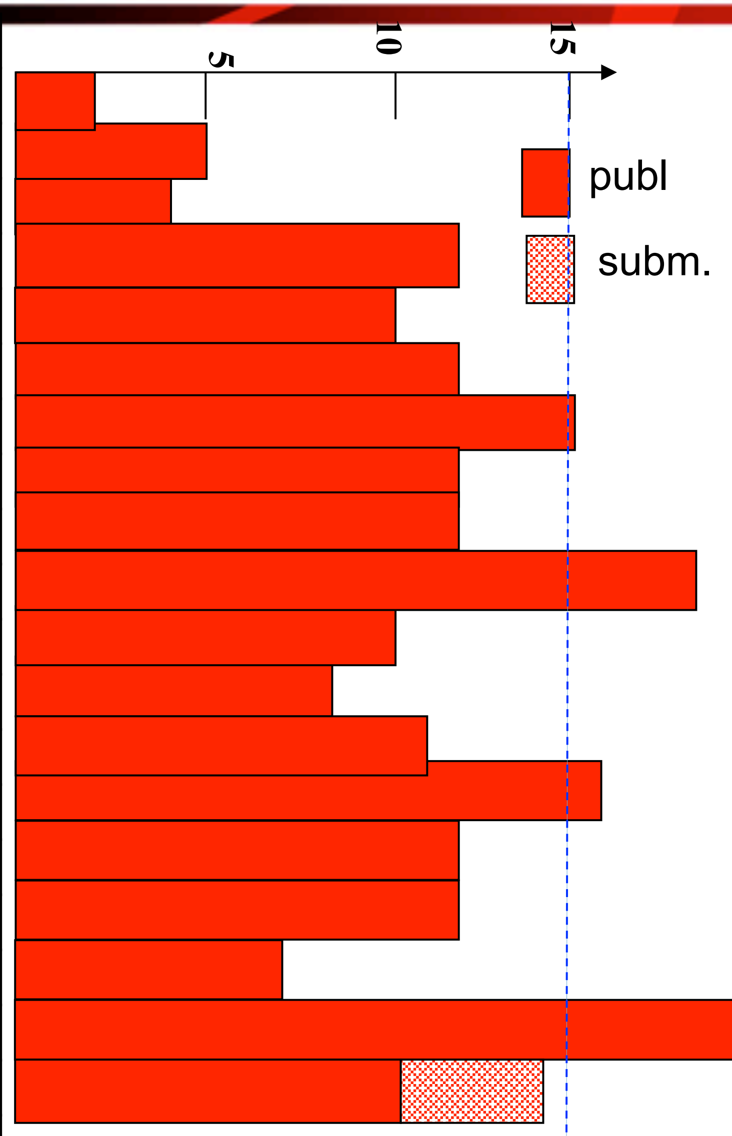
Next Steps:

- *Klystron installation & commissioning ~ Fall/18*
- *beamline to HDice under construction; 1st beam studies in cave-2 ~ Spring/19*
- *1st eHD test with polarized targets ~ Summer/19*



Physics Publications Hall B

	HSWG	DPWG	NPWG	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	12
2006	8	4	3	15
2007	7	2	3	12
2008	4	6	2	12
2009	8	7	4	19
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	5	4	1	10 + 4
SUM	103	67	39	209+4



updated 07 July 2018

JLab Δ(1232) transition FF in RPP 2018

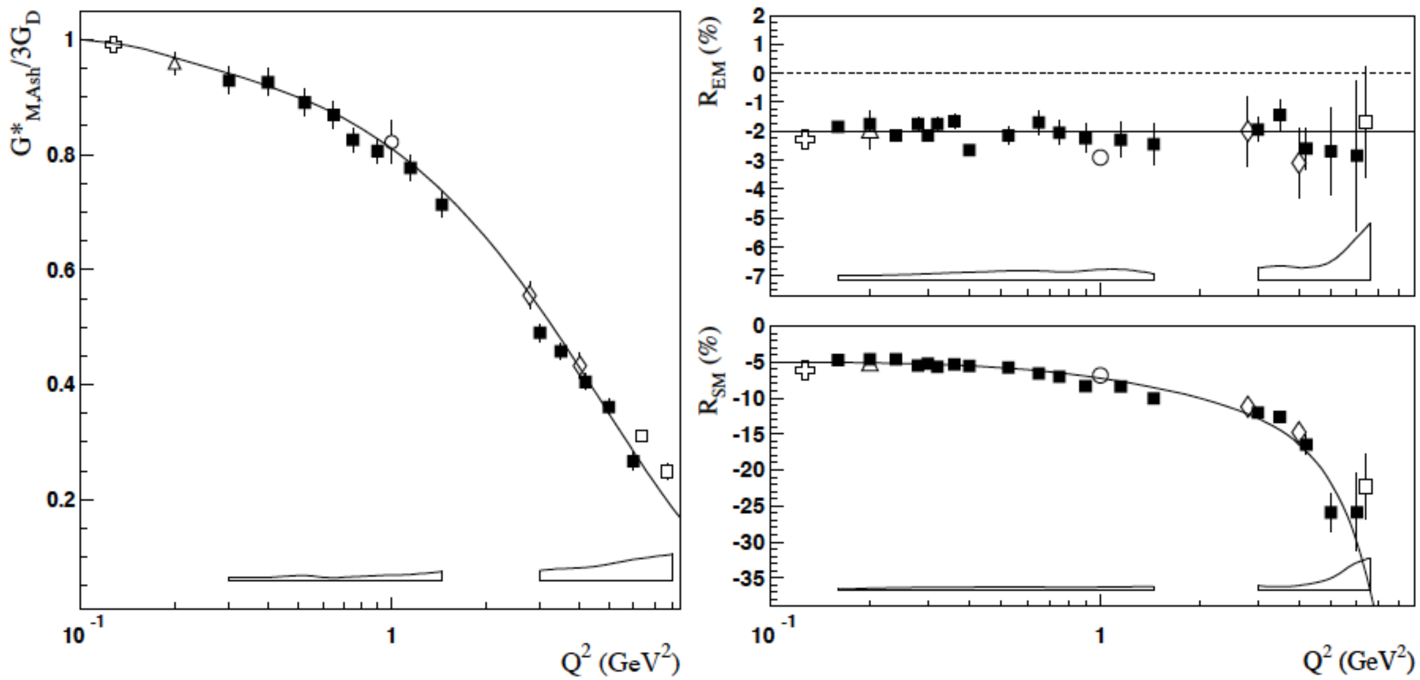


Figure 97.1: Left: The magnetic transition form factor for the $\gamma^* p \to \Delta^+(1232)$ transition versus the photon virtuality Q^2. Right: The electric and scalar quadrupole ratios R_{EM} and R_{SM}. The different symbols are results from different experiments at JLab (squares, diamonds, circle) and MAMI (triangle, cross). The boxes near the horizontal axis indicate model uncertainties of the squares. Curves to guide the eyes.

JLab N* transition FF in RPP 2018