Preparing for GEn-RP and KLL

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GEn-RP Spokespeople: D. Hamilton, M.K., W. Tireman, B. Wojtsekhowski KLL: J. Arrington, A.J.R. Puckett, A.S. Tadepalli, B. Wojtsekhowski

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Thank you for input from

- Senior physicists
 David Hamilton, Will Tireman, Holly Szumila-Vance
- Graduate students
 Sarashowati Dhital

For the latest previous review of GEn-RP (E12-17-004) see
 W. Tireman, SBS Collaboration meeting, July 17–18, 2023

https://indico.jlab.org/event/721/contributions/13219/attachments/10047/14951/Tireman_GEnRP_July17_Update_v2.pdf

- Focusing on updates today
- GEn-RP = E12-17-004 (PAC45)
- KLL = E12-20-008 (PAC48)

G_{En} in absence of a free neutron target

No free neutron target \rightarrow elastic and quasi-elastic scattering

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Nuclear corrections (FSI, MEC, ...)
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Smallness of Gⁿ_E has not allowed L-T sep. of d(e,e'n) or d(e,e')–d(e,e'p)



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Recoil polarization technique for G_E/G_M



- E12-17-004 (GEn-RP): Quasielastic ²H(e,e'n)p
- Use dipole field for spin precession to rotate P₁ and P_n
- Applicable to protons and neutrons

Recoil polarization technique for K_{LL}



$$K_{LL} = \frac{d\sigma(+, \rightarrow) - d\sigma(-, \rightarrow)}{d\sigma(+, \rightarrow) + d\sigma(-, \rightarrow)}$$

• E12-20-008 (KLL):

Wide-angle pion photo production on the neutron, ${}^{2}H(\vec{\gamma},\pi\cdot\vec{p})p$

- Spin correlation between polarized photon and recoil proton
- Large asymmetry expected

Experimental technique of GEn-RP (SBS)

- E12-17-004 will measure GEn/GMn using two recoil pol. techniques at Q² = ~4.4 (GeV/c)²
- "GMn" beam, beamline, target, BB Beam: ~4.3 GeV, ~30 μA, P_b = ~80% Target: 15 cm LD₂ (unpolarized)
 6% Cu radiator (KLL)

 Detector components also used in: Wide-angle Charged Photoproduction (KLL) SBS Inline GEM stack + Steel analyzer

- Scattered electron measured in BigBite
- Charge-Exchange np → pn channel (primary goal) Steel analyzer (passive) GEM tracking + HCAL forward protons

Conventional

- $np \rightarrow np$ channel (secondary goal) Plastic analyzer (active) Large-angle recoil protons \rightarrow Side detectors (GEM + hodoscope) Forward neutron
- \rightarrow HCAL



SBS Neutron Polarimeter (orig. proposed)



 Charge Exchange (CE) Polarimeter

- High-momentum forward protons (towards HCAL) after CE np → pn
- 2 INFN GEM planes
- 6 UVa XY GEM planes
- 1 Fe analyzer
- Proton Recoil (PR) Polarimeter
- Low-momentum large-angle recoiling protons after np → np
- Active CH analyzer
- 2 sections, one each side of CE Polarimeter
- Each section has:
 - 2 UVa GEM planes
 - 1 plastic scintillator plane

Descoping of beamline-side RP arm

UVa XW layers to replace 2 INFN layers (for GEp)

Use only POL-R to demonstrate polarimetry with large-angle recoil protons for P₁

Beamline-side GEMs removed

Analyzing power for elastic n-p scattering



Figure of merit: elastic vs. charge exchange



- Calculate efficiency of polarimeter as function of θ_n by Monte Carlo
- A_y for free np \rightarrow np: JINR fit to p_n and θ_n dependence, scale A_y by 0.5 for ¹²C scattering (agrees with JINR 2016-17 data)
- A_{υ} for np \rightarrow pn on Cu: new 2016-17 measurement from JINR

Geant4 Monte Carlo simulation



FOM study: D. Hamilton (U. of Glasgow)

Rate studies: W. Tireman (Northern Michigan)

- Realistic description of polarimeter components in g4sbs
- Included spin-dependent hadronic processes and precession
- Full quasi-elastic pseudo-data set simulated for expected luminosity
- Two-arm data analysis performed for both CE and PR polarimeter with realistic detector efficiencies and resolutions
- Analyzing power parametrizations based on Ladygin (x0.5) for PR and Dubna results for CE
- Extracted effective analyzing power (due to depolarization), overall efficiency, FOM and statistical uncertainty on polarization components and form factor ratio

Projected form factor ratio uncertainty



GEM status in the Hall

HV upgrade for BB GEMs inside Hall, Dec 2023



4 UV layers before + 1 XY layer after GRINCH Directly supplying HV to each voltage step (CAEN A1515BTG)

GEM status in the Hall

Moving POL-R into Hall, Jan 2024



2 XY layers, continue testing / commissioning on Hall floor

GEM status in the Hall

HV upgrade for POL-R inside Hall, Jan 2024



2 XY layers

2-path, parallel, passive HV dividers Lower total impedance to reduce gain loss at high rate Requiring HV supplies capable of > 1mA/channel (CAEN V6533N; N1470)

SBS inline GEMs to be pulled out for HV upgrades Jan 25 – Feb 15

Timeline

Summer/Fall 2023	Commissioning of POL-R (EEL) with cosmics Commissioning of inline GEMs w/ beam during GEn-I		
Dec 2023	Upgraded HV supplies for BigBite GEMs		
Jan-Feb 2024	Moved POL-R GEMs to Hall, cabling ongoing		
	Pull out inline GEMs; upgrade HV supplies, fix APVs		
Feb-Mar 2024	Build SBS GEM bunker after SBS+HCAL in position		
	Installation of active analyzer and POL-R		
	Cabling		
	Commissioning of XW layers at UVa		
Mar-April 2024	Installation XW layers (if in time)		
	Final checkout		
April – May 2024	GEn-RP + KLL running		
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David Hamilton (Glasgow + student and postdoc): Oliver Jevons (Glasgow postdoc) Gary Penman (Glasgow grad, GEn-II) Will Tireman (N. Michigan + UG students) Ed Brash (CNU + UG students) Nilanga Liyanage (UVa + students) Vimukthi Gamage Bhasitha Dharmasena

M.K. (HU + students and postdocs): Sarashowati (Saru) Dhital (PhD student) Ryan Richards (HU postdoc, 20%) other grad. students (Manju, Tanvi, Angel, Anne) + 1 UG (Krystal) HU postdoc (TBD, 80%)

Responsibilities

List of Tasks to be Done and Personnel v2

Updated: 8-December-2023

Software	Action/Description	Responsible Personnel
DAQ Software	Update DAQ	Alex
Online Analysis	Update SBS Online for new GEMs and GEn-RP hodoscopes/Analyzers	Jiwan/David H. / Gary P.
Offline Analysis/50k/100k	Replay analysis updates for updated/new detectors	Jiwan/David H. / Gary P.
Slow Controls	Integrate new detectors into slow controls	Mark/Bill H.
HV controls	Add new detectors into HV controls	
Alarm Handler	Update alarm handler for new HV supplies	
Equipment		
Cabling	80 PMTs - HV and signals (32 analzyers (1 PMT) and 24 Hodoscopes (2 PMTS)	Bill H.
DAQ Electronics	FADCs and TDCs	Coordinate with Alex/David H.
SBS inline GEMs		Holly/Nilanga
SBS side GEMs		Holly/David H.
GEn-RP Detectors		Bill H.
Target		Meekins
Moller		Donald
BBCal		Kate
Hcal		Jiwan
Beam Line		Bill H.
SBS/BB Magents	Settings: Angles, location, Power supplies	Bogdan/Ellen
Other Items		
RSAD	Update radiation budget pavel@jlab.org	Will Tireman
Safety documents	COO, ESAD, ERG, SAF110 Contact Mark Jones	???
Run Plan development		Bogdan / David H
Shift Schedule and Policy	20 days, 120 shift persons + RCs	Michael Kohl

Personnel Able to Provide

Assistance		
Saru Dhital		
Andrew Cheyne		
Will Tireman		

Physics liaison: Bill Henry

Thank you!

Questions?

Backup