Hall A/C

SBS future

(beyond EM Form Factors):

Nucleon Axial Form Factor

BA / RM1 + GE / LNF expression of interest+

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(JLab, Temple Univ., Jagellonian Univ., La Sapienza, UniSalento, Virginia Tech.)

SBS future

SBS Experimental Program Status

FF	GMN (E12-09-019)	GMn/GMD up to 13.5 GeV2 (perspective to 18 GeV2)	Ratio Method D/H	done, 2021
	nTPE (E12-20-010)	Rosenbluth slope in e+n scattering at Q2=4.5 GeV2, with high accuracy	Same apparatus of GMN; measure s(e,n)/s(e,p) on deuterium	done, 2021
	GEN-II (E12-09-016)	GEn/GMn up to 10 GeV2	Beam-target double spin asymmetry on polarized 3He	done, 2023
	GEN-RP (E12-17-004)	GEn/GMn at 4.5 GeV2	Charge-exchange recoil polarimetry (first time!), on deuterium	done, May/24
	GEP-V (E12-07-109)	GEp/GMp to 12 GeV2 (perspective to 15 GeV2)	Polarization Transfer (the most demanding SBS experiment)	**Jun/24 → Install → Feb/25 → Run → Aug/25**
	(E12-23-004)	Strange Quark Form-Factor of p	Parity Violating Electron Scattering on H2	Aprroved 2023
GPD	WAPP (E12-20-008, E12-21-005)	A_{LL} / K_{LL} from $g^{-}n \rightarrow p^{-} p^{-}$	Pioneering measurements; same apparatus of GEN*, on ^{3}He and LD_2 target; Cu radiator for g production	A_{LL} cancelled; K_{LL} done, May/24
	(p)WACS (E12-17-008)	$A_{LL,LS}$ / $K_{LL,LS}$ in $g^{-}p^{+} \rightarrow g^{-}p$	Compact Photon Source + Neutral Particle Spect. + BB/SBS + GEM Tracker + HCal	
TMD	**SIDIS (E12-09-018)**	Extract Sivers, Collins and Pretzelosity neutron asymmetries on p and K with high statistics in high x valence region	Transversely Polarized ^{3}He Target 3D binning on the relevant variables: x, P_{perp} and z, for both hadrons; 2 Q^2 values	Hall C > 2025 ?
PDF	TDIS (C12-15-006A/B)	Measure p/K F2 in valence regime	Exploit Sullivan process e+N → e'(gp)N' → e'XN' tagging the spectator N'	Hall C > 2025

After GEP-V (2025):

- Relocation to Hall C
- Completion of submitted/approved measurements
- Definition of new program (also beyond EM F.F.)

2024 Summer Hall A/C Collaboration Meeting

15-16/Jul/2024

https://indico.jlab.org/event/843/

17:30 **The Future of SBS**

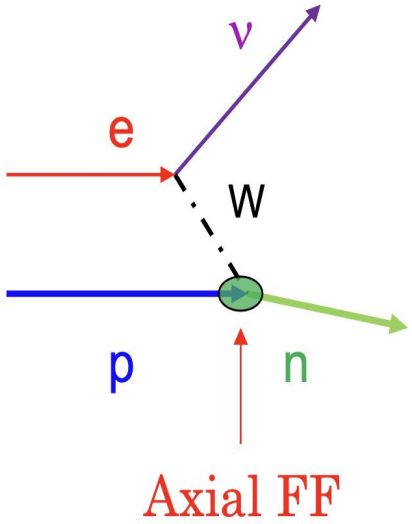
Speaker: Bogdan Wojtsekhowski (Jefferson Lab)

Nucleon Axial Vector Form Factor at Q^2=1 $(GeV/c)^2$

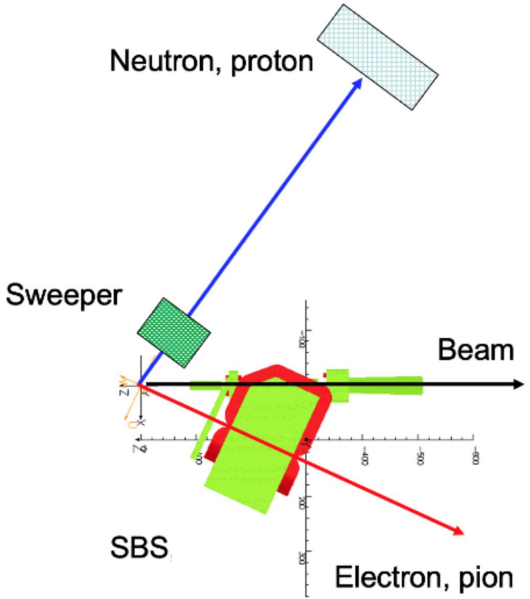
LoI - PAC52

Authors:

J. Napolitano, B. Wojtsekhowski, and P. Degtiarenko, A. Deur, J. Golak, D. Jones, C. Keppel, D.E. King, E. Cisbani, R. Perrino, O. Benhar, D. Armstrong, T. Averett, M. Bukhari



W exchange



Layout of the proposed experiment.

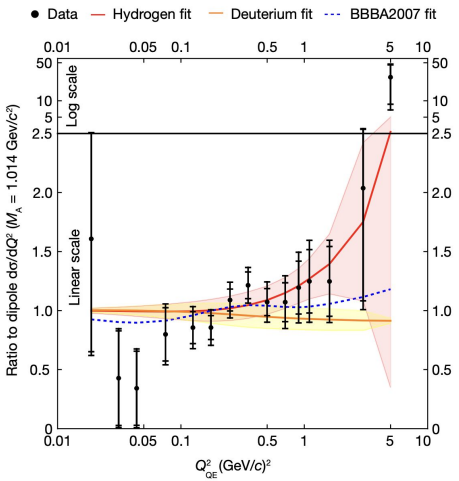
Nucleon Axial Vector Form Factor at Q^2=1 (GeV/c)^2

Physics motivation: The knowledge of the nucleon axial FF is critical for the understanding of neutrino-nucleus interaction and consequent neutrino oscillations parameters. In addition it would extend the knowledge of the PV nucleon dynamics not accessible by electromagnetic probes.

Existing measurement of the nucleon axial FF are from neutrino QE scattering and are: scarce (mostly bubble chamber) + statistically limited + largely affected by systematics + in tension with lattice QCD calculations.

A direct/clean measurement of the axial FF, potentially feasible with established techniques and performant detectors typical of recent JLab EM FF experiments, would be fundamental.

The common ansatz of a dipole FF with M_A~1 GeV/c^2 is shown to be affected by large uncertainty by recent work (T. Cai et al., 2023; *MinerνA*). Even a single point from an independent precise measurement in the 0.2-1.2 (GeV/c)^2 would provide a very significant constraint.



T. Cai et al., 2023 Nature, Vol. 614

Measurement concept (fully exploit JLab precision methods with EM Form Factors):

$H(e^-,\nu_e)n \rightarrow$ kinematics fully constrained

1) *10-cm long LH2 target*
2) *100 μA highly polarized 2.2 GeV electron beam*
3) *Efficient vetoing the elastic scattering H(e,e')p and the pion production → SBS spectrometer*
4) *Efficient counting neutrons with <100 ps time resolution*
5) *Magnet sweeper for softer charged suppression*

Figures:

$\sigma_W/\sigma_{EM} \sim 10^{-8}$

High beam polarization:

Weak asymmetry 100%

EM asymmetry 0%

S/N aim: 10^{-3} - Projected FF accuracy ~ 15%

Nucleon Axial Form Factor Experiment

The neutron detector proposed:

2 x 8.5 m^2 active area @ 15 m (75 msr)

~980 6x6 cm^2 plastics (140/layer)

<100 ps timing (FTOF@CLAS12, D. Carman, NIM A960(2020)163629)

Currently under GEANT4 studies (Evaristo+Roberto)

Plan:

2024 - LoI to PAC52 [OK]

2025 - Experiment Proposal Completion

Current activities:

- **Undergraduate thesis** in Lecce (cross section calculation and measurement discussion)
- **Monte Carlo** simulation for **neutron detector** characterization
- **Draft paper** with physics motivation, review of current experimental status of knowledge of weak axial FF, and experiment proposal

Nucleon Axial Form Factor Experiment

Collaboration build-up

Prompt feedback from nuclear physics theorists with interests in neutrino-nucleus interactions:

Omar Behnar (La Sapienza and INFN Roma)

Luca Girlanda, **Giampaolo Co'** (Università del Salento and INFN Lecce)

Close interplay established with **nTOF Collaboration** for the neutron detector development and test (+nTOF multiple energy beam accessibility).

Exploring potential involvement of:

- **neutrino physics community**
- **Ti/Ar structure functions Hall A groups**

INFN **GE**

Discussion on measurement feasibility /// neutron detection

INFN **LNF**

Neutron detector /// Access to FINUDA TOFONE

Attività prevista 2025:

- Monte Carlo neutron wall ed esperimento per proposal
- Prototipo scintillatore per neutroni per futura validazione MC
- Caratterizzazione scintillatore+fotorivelatori per neutroni on bench
- Validazione MC @ nTOF (2025+)

Valutazione scintillatori da apparati già esistenti: **FINUDA TOFONE**?
Contatti già presi e in corso (BA/LNF).

Spese previste (BA: 2.5-3.0 kEur; RM1: 2.5-3.0 kEur)(*):

- 2 Scintillatori (BC408+alternativo) 6 x 6 x 200 cm3 ~ 2000 Eur
- 4 Fotorivelatori(**) (2+2 MPPC Hamamatsu tipo diverso) ~ 3600 Eur

(*) Sharing acquisto o opzione unico centro di spesa da decidere
(**) Si intende provare MPPC tipo diverso o mix MPPC/PMT

- BACK-UP

Costo dell'esperimento (very preliminary)

(rough estimate, as from discussion with JLab Collaborators):

Copertura di 75 msr @ 15 m dal bersaglio

~1500 scintillatori 6x6x200 cm3 disposti in 12 layers da 125ctr/layer

- Scintillator bar ~ 1000 $
- Two photodetectors ~ 2 x 700 $

→ Total cost TOF system ~ 1500 x (1000+2x700) → 3.6 M$

HV → GRATIS (da esperimento GEP-V)

DAQ → ipotesi VME @ 25ps resolution → 2-3 M$

... ma in esplorazione soluzione alternativa di lettura SiPM con sistemi FERS/CAEN

Trigger Neutron Arm → Calorimetro HCAL → 300k$

Sweeper magnet for neutron arm → 300 k$

COSTO stimato → 7.5 M$