Minisession on the extension of the polarized ND3 CLAS12 run group



CLAS Collaboration meeting, 2/25/2015





Purpose of this session

PR12-15-004: Deeply Virtual Compton Scattering on the neutron with a longitudinally polarized deuterium target (A. Biselli, C. Keith, S. Niccolai, S. Pisano, D. Sokhan):
Presented at PAC43, requesting 100 days (plus overhead) of running time on ND3, 50 shared with the existing run group (RG-Cb), plus 50 days of new beam time

Conditionally approved (C2) by the PAC, must come back to the next PAC, broken into TWO proposals: a « parasitic » one for the already-approved 50 days (needing only CLAS approval), and a new proposal, requesting new beam time, that will go through the PAC
For the new proposal, it was asked to add other physics channels (« up to 3 physics topics plus a summary of additional topics ») to better support and motivate the need to extend the existing run group

• Current idea: nDVCS, DIS, SIDIS, as the three main channels, with simulations and count-rates estimates; a few paragraphs concerning physics interest and faeasibility for nDVMP, nTCS (N*?)

Approved DVCS experiments for JLab@12 GeV

Proton Neutron

Observable	Target	Sensitivity	Completed	12-GeV
(target)		to CFFs	experiments	experiments
$\Delta \sigma_{beam}(\mathbf{p})$	Unpolarized hydrogen	$\Im m \mathcal{H}_p$	Hall A, CLAS	Hall A, CLAS12, Hall C
BSA(p)	Unpolarized hydrogen	$\Im m \mathcal{H}_p$	HERMES, CLAS	CLAS12
TSA(p)	Long. pol. NH3	$\Im m \mathcal{H}_p, \Im m \mathcal{H}_p,$	HERMES, CLAS	CLAS12
DSA(p)	Long. pol. NH3	$\Re e \mathcal{H}_p, \Re e \mathcal{H}_p$	HERMES, CLAS	CLAS12
tTSA(p)	Transv. pol. protons	$\Im \mathcal{H}_p, \Im \mathcal{H}_p$	HERMES	CLAS12
$\Delta \sigma_{beam}(\mathbf{n})$	Unpolarized deuterium	$\Im m \mathcal{E}_n$	Hall A	
BSA(n)	Unpolarized deuterium	$\Im m \mathcal{E}_n$		CLAS12
TSA(n)	Long. pol. ND3	$\Im m \mathcal{H}_n$		PR12-15-004
DSA(n)	Long. pol. ND3	$\Re e \mathcal{H}_n$		PR12-15-004

A complete experimental program is approved for proton DVCS (CLAS12, Hall A, Hall C)

Only the beam-spin asymmetry measurement $(Im(\mathcal{E}_n))$ for neutron DVCS is currently approved for JLab@12 GeV

Polarized neutron DVCS setup



nDVCS: projected target-spin asymmetry

100 days



nDVCS: projected double spin asymmetry 50 days 50 days



nDVCS: Projected beam spin asymmetry from E12-11-003

✓ Count rates
 computed with
 nDVCS+BH
 event generator
 + CLAS12
 acceptance from
 FastMC
 + CND efficiency
 from GEANT4
 simulation
 ✓ Asymmetries
 computed with
 VGG model

- 4 bins in Q^2
- 4 bins in –t
- 4 bins in x_B
- 12 bins in ϕ

High-impact experiment



XB

Combined analysis of PR12-15-004 and E12-11-003



Combined analysis of PR12-15-004 and E12-11-003



Flavor separation of GPDs

Proton and neutron GPDs (and CFFs) **are linear combinations of quark GPDs**

$$\mathcal{H}_{p}(\xi,t) = \frac{4}{9} \mathcal{H}_{u}(\xi,t) + \frac{1}{9} \mathcal{H}_{d}(\xi,t)$$
$$\mathcal{H}_{n}(\xi,t) = \frac{1}{9} \mathcal{H}_{u}(\xi,t) + \frac{4}{9} \mathcal{H}_{d}(\xi,t)$$
$$\mathcal{H}_{n}(\xi,t) = \frac{9}{9} \left(4\mathcal{H}_{n}(\xi,t) - \mathcal{H}_{n}(\xi,t) \right)$$

A combined analysis of DVCS observables for proton and neutron targets is necessary to perform the flavor separation of the GPDs

$$\mathcal{H}_{u}(\xi,t) = \frac{9}{15} \left(4\mathcal{H}_{p}(\xi,t) - \mathcal{H}_{n}(\xi,t) \right)$$
$$\mathcal{H}_{d}(\xi,t) = \frac{9}{15} \left(4\mathcal{H}_{n}(\xi,t) - \mathcal{H}_{p}(\xi,t) \right)$$

Measurements of DVCS on neutron target are crucial for the completion of a comprehensive GPD program for JLab@12 GeV

We propose to extend the JLab experimental program for nDVCS, started with the beam-spin asymmetry (E12-11-003), by measuring for the first time target-spin single and double asymmetries

Projections for flavor separation (*ImH*, *ImE*)



Summary of setup and beam-time request

Experimental setup:

- CLAS12
- Longitudinally polarized ND₃ target (P_t~40%)
- Central Neutron Detector (ready!)

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Beam energy: 11 GeV
Beam polarization: 85%
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Production data taking at 10^{35} cm ⁻² s ⁻¹ on ND ₃	100 days
Target work	12 days
Production data taking on ¹² C target	10 days
Moeller polarimeter runs	3 days
Total beam time request	125 days

Half of the requested beam time can be shared with <u>Run Group Cb</u> We request <u>62 days of new beam time</u>

CLAS12 experiments and run groups

Proposal	Physics	Contact	Rating	Days	Group	New equipment	Energy	Run Group	Target
E12-06-108	Hard exclusive electro-production of π^0,η	Stoler	В	80	RICI Forv	RICH (1 sector)	11		liquid
E12-06-112	Proton's quark dynamics in SIDIS pion production	Avakian	A	60		Forward tagger			H ₂
E12-06-119	Deeply Virtual Compton Scattering	Sabatie	А	80				Δ	
E12-09-003	Ex citation of nucleon resonances at high Q ²	Gothe	B+	40					
E12-11-005	Hadron spectroscopy with forward tagger	Battaglieri	A-	119				F. Sabatie	
E12-12-001	Timelike Compton Scatt. & J/ψ production in e+e-	Nadel-Turonski	A-	120					
E12-12-007	Exclusive $\boldsymbol{\phi}$ meson electroproduction with CLAS12	Stoler, Weiss	B+	60					
PR12-12-008	Photoproduction of the very strangest baryon	Guo	ł	80					
E12-07-104	Neutron magnetic form factor	Gilfoyle	A-	30	90	Neutron detector RICH (1 sector) Forward tagger	11		liquid
PR12-11-109 (a)	Dihadron DIS production	Avakian	-	-				В	D ₂ target
E12-09-007a	Study of partonic distributions in SIDIS kaon production	Hafidi	A-	56				K. Hafidi	
E12-09-008	Boer-Mulders asymmetry in K SIDIS w/ H and D targets	Contalbrigo	A-	TBA					
E12-11-003	DVCS on neutron target	Niccolai	А	90					
E12-06-109	Longitudinal Spin Structure of the Nucleon	Kuhn	A	80	170 (50 day s	Polarized target RICH (1 sector) Forward tagger	11		NH ₃
E12-06- 119(b)	DVCS on longitudinally polarized proton target	Sabatie	A	120					ND ₃
E12-07-107	Spin-Orbit Correl. with Longitudinally polarized target	Avakian	A-	103				С	
PR12-11-109 (b)	Dihadron studies on long. polarized target	Avakian	11	-				S. Kuhn	
E12-09-007(b)	Study of partonic distributions using SIDIS K production	Hafidi	A-	110					
E12-09-009	Spin-Orbit correlations in K production w/ pol. targets	Avakian	B+	103					
E12-06-106	Color transparency in exclusive vector meson production	Hafidi	B+	60	60		11	D	Nuclear
E12-06-117	Quark propagation and hadron formation	Brooks	A-	60	60		11	E	Nuclear
E12-10-102	Free Neutron structure at large x	Bueltman	А	40	40	Radial TPC	11	F	Gas D ₂
TOTAL approved run time (PAC days)				1491	559				