Comments on CLAS Run-Group F additional proposal: Neutron DVCS Measurements with BONuS12 in CLAS12 by M.Hattawy et al.

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The authors are proposing an addition to RG-F to study the deeply virtual Compton scattering on neutrons (nDVCS) using a deuterium gaseous target. The experimental setup of RG-F, and in particular the BONuS12 radial TPC, is particularly well suited for the detection of the low-momentum spectator proton giving the possibility to study the impact of Fermi motion and final state interactions on nDVCS.

This experiment is planning to use tagged nDVCS ($\gamma^* + D \rightarrow \gamma + p + (n)$), and fully exclusive nDVCS ($\gamma^* + D \rightarrow \gamma + p + n$) events. Although a large difference in the expected statistics between the two channels, their comparison will allow one to better understand systematic uncertainties in the tagged nDVCS analysis. In addition, these proposed measurements will complement and possibly help in the understanding of the impact of Fermi motion and FSI on the analysis results of RG-B.

This proposal demands only one major modification to the foreseen RG-F data taking plans: a highly polarized electron beam. The proponents state in this proposal that the RG-F spokespersons already agreed to allocate the necessary time to perform polarization measurements, therefore this request represents a beneficial addition to the RG-F program, because it will enable not only the analysis of this particular channel but possibly many other analyses.

The current draft is well documented, but we suggest the proponents to better highlight the importance of the nDVCS measurements and the complementarity with respect to RG-B. The following comments and questions aim at helping to clarify and improve the proposal. Detailed comments and text corrections in the following section.

General comments

- The authors should further develop the significance of the FSI and Fermi motion. What is the constraining power of the expected results over these effects?

- There should be more details on how this proposal is a "companion" of the RG-B proposal. What does this analysis intend to accomplish differently from RG-B?
  E12-11-003 quote total 8% systematic uncertainties, while in this proposal estimated uncertainties are 20%. Do you have a quantitative evaluation on how much improvement this experiment is going to impose over the 12-11-003 experiment?

- The experiment is planning to run with 5 times less luminosity than the CLAS12 designed luminosity, and hence these runs are expected to have smaller background and, so, larger tracking efficiency in the forward detector.
  But during the RG-A and RG-B data taking, the beam current was limited to about 2/3 of the nominal request due to occupancy in the tracking detector higher than expected. Did you consider how much would the loss of statistics impact the expected results?

- Do Moller electrons represent an issue for the tracking performance?

- It is not explained why the solenoid will be set at 5 Tesla. Since this proposal aims at measuring the low-momentum spectator proton, one would guess that a lower magnetic field would allow reaching lower momenta. Was this considered?

- What is the recoil proton momentum resolution? There is no discussion on the tracking of such low energy protons in the solenoid. How big is the impact of the proton reconstruction resolution on the final results on FSI and Fermi motion?
  In the text there is also a remark regarding the fact that the reconstruction with BONuS12 is not yet finalized. We suggest to smoothen the fact that the tracking is not yet included in the CLAS12 framework and to give an estimate on when it will be.

- In the experimental setup, there is no mention of the Forward Tagger. Did you consider including it? Given that RG-B is running with FT, what will be the impact on the comparison between the two experiments of not including the FT?

- There is no mention of trigger requirements for this measurement. Will you use the same trigger as the BONuS12? Is it just an electron trigger with certain electron momentum range? Please specify.

- Systematic uncertainties.

  - It is written that "normalization and efficiencies [...] cancel out in the asymmetry ratio". This is true only if the data taking conditions do not change in time, i.e. all the runs considered have very similar conditions.
  - There is a mention of non exclusive π^0 background. What do you mean by "non exclusive"? What about the exclusive production of π^0 with either a missing photon or merged photons? Since this is the major background contribution for the e-p data, could you elaborate more on this source of background?
  - Last paragraph of page 25. Varying the exclusivity cuts means that you change the amount of signal that you accept, therefore the obtained uncertainty also contains a statistical part. Was this taken into account?
  - Fit sensitivity. What function was used? How this dependence of the binning was evaluated? Did you change the functional form?

Detailed comments

- Introduction. Line 5. Change "motion of partons" in "longitudinal motion of partons".

- Chapter 1. Avoid technical jargon or it needs to be introduced.

- Page 9, line 9. "proposal is enhance" $\rightarrow$"proposal is to enhance".

- Page 9 2^{nd} paragraph, A question on the following sentence "However, the impact of the uncertain initial state and the final state interactions on the integration of these data in global fits remain unclear."
  - How this proposal is going to address/answer to this question. See General comments.

- Page 9, 4th line from the bottom. "systematic errors" $\rightarrow$"systematic uncertainties".

- Page 10, line 1. "plagued" $\rightarrow$"affected".

- Page 10, line 6. "... the sin component of the beam spin asymmetry". The BSA is not yet introduced, therefore is jargon to discuss the sin component.

- Page 10. Eq 1.1 contains Compton form factors that aren't mentioned yet. Again, a non super expert reader may be lost.

- Pege 12 Formulas (1.7), (1.8) and (1.9)
  -Typo: *cos* with s_n coefficients should be *sin*.

- Page12 1^{st} line: "are called Fourier coefficients and they depend..."
  might be better to change "are called Fourier coefficients. They depend..."

- Page 12. After Eq 1.12, expand on why you want to measure the BSA.

- Page 13. "... uncertainties in detection". Unclear, please rephrase.

- Page 13. Line 10. "... published data is ..." $\rightarrow$"published data are..."

- Page 14. Line 1. "... helping with nuclear effects" $\rightarrow$"... helping in the understanding of the nuclear effects".

- Page 14 3^{rd} paragraph: "wesee calculation"
  - A typo "we see calculation..."

- Page 14 3^{rd} paragraph: "At low recoil momentum and backwards spectator angle, the FSIs are negligible, whereas at high momenta perpendicular to the momentum transfer, FSIs are maximized"
  - This doesn't seem to be consistent with Fig1.5 that you are quoting. It seems labels in the left plot of Fig. 1.5 are wrong. Probably it needs to be changed: $0^\circ \rightarrow 180^\circ$, $180^\circ \rightarrow 90^\circ$, $90^\circ \rightarrow 0^\circ$.
  - PWIA not defined.

- What is your intention about large and small FSI regions.
  - Fig. 3.10 shows bins with different momentum and angles, but it is not clear what you are planning to do in order to understand better FSI and initial motions of nucleons in the deuterium (or nuclei).

- Page 16 2^{nd} paragraph: "and eg6 (E08-024)experiments"
  - Add space between (E08-024) and experiments.

- Page 17 3^{rd} paragraph "The charged particle identification in the forward detector is achieved by utilizing the combination of the HTCC, LTCC and TOF arrays with the tracking information from the Drift Chambers."
  - LTCC is present only in four sectors, and a proper gas mixture is only in one sector. Most of charged particle identification doesn't use LTCC. You might skip LTCC, or otherwise if for completeness you want to include it, then you might want to add RICH as well.

- In the summary page, " *The first channel will enrich our knowledge about the partonic structure of the quasi-free neutrons, while the fully exclusive neutron DVCS measurement will be a golden data set to understand the Fermi motion and final state interaction effects on the measured DVCS beam-spin asymmetries.*"
  - It was not clear how exactly you are going to learn more about FSI and Fermi motions with proposed measurements. See also the General remarks.