# First round comments from Markus Diehl on the proposal "Neutron DVCS Measurements with BONuS12 in CLAS12"

July 16, 2019

1. In the abstract and summary, you state the goal of 'understanding the (impact of) Fermi motion' in DVCS and beyond. As far as I see, the variables $x^*$ and $W^*$ you introduce and discuss are designed to 'bypass' or 'take into account' the effect of Fermi motion for extracting DVCS on the neutron. But that alone does not give any 'understanding' of these effects, does it?. For this, I suppose, you would need to consider additional kinematic quantities, and/or compare different distributions. Can you expand a bit on that point?

   Response: When tagging, we not only reconstruct the corrected variables $x^*$ and $W^*$, we also select a specific phase space of the spectator. This not only impacts the result because of the Fermi motion itself, but also because of other processes that get in our sample because of Fermi motion (in many cases there is no more spectator as it gets involved in the reaction). Altogether, the impact of Fermi motion is complex and needs to be carefully modeled, this data will offer a unique opportunity to validate theoretical calculations. Since theory is not existent for tagged DVCS yet, we can only speculate on the right observable to make the best test of the calculations. However, by analogy to the tagged DIS (the main Bonus measurement) we can assume that the angle of production of the spectator will be very important to study.

2. You present in detail the envisaged comparison of data you would take in the run addition with or without tagging the scattered neutron. Can you also say something about how you would compare that data with the one from E12-11-003 (without the tagged proton), and what specifically one could then learn from that comparison? This would make the complementarity between the run group addition and E12-11-003 more concrete. How could one, for instance, correct the E12-11-003 data for nuclear effects based on the measurement you propose?

   Response: Some of the answer is above already. To complete, the main idea here will be to check that the integrated result from E12-11-003 will not suffer from a large bias. If this is small, there is not much more to do and this data will simply provide a few more points for GPD fits. If the effect is significant however, the comparison to our new data of the model used to correct the E12-11-003 is going to be key. It would be very difficult to correct something never measured. We want to emphasize here, that while tagged measurements exist for relative cross sections, it remains largely unknown how this affects beam-spin asymmetries.

3. You emphasize on p.30 that existing model predictions for FSI effects are not available for DVCS. Despite this caveat, I think it might be a useful illustration to see in a figure how the size of effects shown for inclusive DIS in Fig 1.5 compares with your anticipated uncertainties for $A_{LU}$ in DVCS in Fig 3.12 (unless you argue that this makes little physics sense).

   Response: As mentioned above, there is no indication that the beam-spin asymmetry will be affected in a comparable manner. However, if this was the case, at large angles ( 90 degrees) corrections can be massive (about factor 2) and can definitely be seen without any problem. In the region of interest (low momentum backward spectator protons), cross section is modified by 10-20%, which should be smaller than what we can resolve since the asymmetries are only about 5% in the first place.

4. Incidentally, if effects on $A_{LU}$ were similar to those in Fig 1.5, then a bin of $0.12GeV < p_s < 0.35GeV$ may wash out the FSI effects for $\theta_s = 90$ degrees by averaging over regions of suppression and enhancement. Perhaps you can say something about the flexibility to choose different bins in $p_s$ in order to cope with such an eventuality? (Looking at Fig 3.10, I guess that you could also just select $0.12GeV < p_s < 0.25GeV$ or so, but you can probably make a more informed statement.)

   Response: You are correct. The final bins haven't been chosen yet since they depend on the experimental resolution and acceptance of the RTPC for spectator protons.

5. On p.16, you write that "the measurement of this channel [with tagged spectator proton] will offer a slightly smaller amount of data as other CLAS12 measurements." On p.27, you estimate 9 million proton-tagged neutron DVCS events, whereas in the proposal of E12-11-003 (p.49 of the proposal to PAC 37) I find an estimate of 25 million DVCS/BH events. Are these the relevant numbers to compare?

   Response: Yes, you are correct. However, RG-B has been approved to run about half the approved days this year and BONuS12 will be running before the other half of RG-B.

6. The right-hand plots in Figures 3.1, 3.3, and 3.4 show a rather 'fractured' acceptance in different azimuthal angles. Does this have an adverse effect on your acceptance in the angle phi (the one mentioned on p.27)? Do you have an acceptance plot for that angle?

   Response: This is not really a problem as phi is the difference between two planes that depend also on azimuth angles. However, the final phi distribution, while looking continuous is full of holes when plotted in more than 1-D. This has been a common issue in CLAS for many studies for a long time and is resolved through acceptance corrections. This is a tedious process, but difficult to avoid with the detector as it has been built.

7. Finally, let me repeat the question raised in the TAC report: can you give an estimate of how much loss in beam polarization you could tolerate without compromising the physics output? Additionally, are there important observables that may be less sensitive to this (I am thinking of the ratio of $A_{LU}$'s in Figure 3.12)?

Response: The polarization reduction affects linearly our results. Simply put, our error bars are constant, but we measure half the asymmetries if we have only half polarization. This is rather critical in this measurement because the neutron asymmetries are expected to be much smaller than on the proton (about 5%). If the polarization is significantly lower than on design, it is very likely that the comparison with E12-11-003 will not provide much significance. To test models, the measurement is more resilient. As was mentioned, we can select parts of the phase space where strong variations are expected and this can be tested even with lower polarization.