Dihadron SIDIS Proposal review – round 2

Title

Studies of Dihadron Electroproduction in DIS with Longitudinally Polarized Hydrogen and Deuterium Targets

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Review Committee

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General comments:

Given the large overlap with the experimental conditions of RG-C and the lack of a physics case strong enough to justify the request of 208 new PAC days, **the Review Committee endorses the decision of the proponents to reformulate the original proposal into an RG-C addition**, as also solicited by a recent and well-motivated email sent by the RC-C Spokesperson to the proponents.

A new version of the Proposal, triggered by the explicit request (in the aforementioned email) of making more evident and explicit this decision, has been circulated by the authors during the second round of this review. The comments below are based on this latest version.

Although clear statements have been added in the title, abstract, introduction and summary, **the request of 208 PAC days still persists in the Summary section, as also detailed in Table XIV**.

Since a run group addition cannot get any new (or different) beam-time condition than already approved by the PAC, this whole part needs to be removed or severely reformulated. Furthermore, in many parts the text still seems to point to a new dedicated experiment (see e.g. sentences in lines 499, 527, 563, 719, 808, etc.). So, please also adjust the text wherever it still refers to a new experiment proposal.

The request of additional beam-time (e.g. 60 more days) with the ND3 target, motivated by the lower polarization degree, cannot be achieved in the framework of an already-approved Run Group. Rather, its usefulness, if well motivated and supported by projections, could in principle motivate a dedicated (and focused) experiment proposal for a next PAC.

Last but not least, the possibility to extend the proposed analysis to a different data set, based on the use of a 3He target (as discussed in another proposal to be submitted to PAC48), although physically motivated, risks to generate confusion and to feed the idea of a not well-focused research program.

Finally, the Review Committee appreciated the improvements in the Polarized Target Section and, especially, on the “Event Selection Criteria” and “Asymmetry Measurements” subsections, as well as the addition of other projections (and tables) and the more thorough discussion on the systematic uncertainties.

Detailed requests on the text (based on the latest version circulated)

Fig. 11 is not extracted from ref. [132] . Please quote also the source of this plot.

499: “The proposed experiment will run in similar conditions to an already approved CLAS12 proposal” -> “The proposed measurement will be carried out in the framework of an already approved CLAS12 proposal”. You should make it clear that this proposal is an addition to RGC rather than a proposal for a new experiment.

507-525: The sentences of this paragraph should be reordered for a better logic flow, as follows:
“In the baseline design of CLAS12 [137, 138], particle identification (PID) in the forward detector is obtained by using a high threshold Cerenkov counter (HTCC) [139], a low threshold Cerenkov counter (LTCC) [140] and a time-of-flight scintillator arrays (TOF) [141, 142]. In the ~2.5-5 GeV/c momentum region, the pi-K separation relies only on the LTCC performance, and it is not possible to separate protons from Kaons in the 4.7-8 GeV momentum region. While, in general, this PID system matches the requirements of the physics program at 12 GeV, it turns out to be insufficient for some physics reactions of high interest, such as the ones covered by this proposal (requiring charged kaon detection). More specifically, since the K/pi production ratio is of the order of 10-15% (see figure 12), a very high rejection factor for pions is needed in order to keep the contamination of misidentified kaons at a few percent level, while, with the baseline configuration and assuming a 10% pion detection inefficiency for the LTCC, the pi/K contamination is 1:1. An improved hadron PID is therefore needed, which can be achieved with a Ring Imaging Cherenkov (RICH) detector. Currently, one of the CLAS sectors (out of 6) is covered by a new RICH detector [143], which has been installed in place of the LTCC. The RICH ensures a 1:500 rejection factor for pions, corresponding to a 4σ pion-kaon separation in the 3-8 GeV/c momentum range. A second RICH detector, currently under construction, is planned to be ready by the time of the proposed run period. With the two RICH detectors in operation, installed in opposite sectors, it will be possible to meet the PID performances needed for SIDIS dihadron measurements with pi-K and K-K final-states where the kaon has large momentum. Note, that since in the dihadron channel the momentum is shared between the outgoing hadrons, one of the hadrons usually has a low enough momentum to be discriminated with the CLAS12 baseline PID detectors (i.e. without the RICH).”

547-550: “To determine …with CLAS12” Be more specific: when and how are you getting these measurements if that is not part of RGC?

619: how is z_h1h2 defined? Why do you call it “Fragmentation function”? It should be the “fraction of the virtual-photon energy carried by the produced dihadron system”. But then 0.95 is a quite high value, and by sure includes part of the exclusive region (contrary to what is written). Furthermore, it is in contradiction with the z-range reported in 805 (0.2<z<0.8).

621: the x_F>0 requirement helps in selecting the current fragmentation region, but does not exclude contributions from the target fragmentation region (as you correctly say in 630-631). Rephrase (e.g. “to enhance the probability that both are produced in the CFR”)

635+6: “Defining …” the notation is not clear. What is the meaning of the “+/-” index? Why do you need to repeat the “+/-” index in the right-hand terms?

679: “IFF H1, and with measurements by Belle [57], can be used to extract” -> rephrase as: “IFF H1. These measurements, in conjunction with those by BELLE on the IFF [57] allowed to extract…” Then add some reference of this extraction:

- Bacchetta, A. Courtoy and M. Radici, First extraction of valence transversities in a collinear framework , JHEP 03 (2013) 119 [1212.3568].
- M. Radici, A. Courtoy, A. Bacchetta and M. Guagnelli, Improved extraction of valence transversity distributions from inclusive dihadron production , JHEP 05 (2015) 123 [1503.03495].
- J. Benel, A. Courtoy and R. Ferro-Hernandez, A constrained _t of the valence transversity distributions from dihadron production , Eur. Phys. J. C 80 (2020) 465 [1912.03289].

698: “however, more days on ND3… h_L^ud” -> “Note: the shorter data-taking period allocated for the RG-C for the ND3 target, as compared to that for the NH3 target, will result in a lower statistical precision for the former measurement (especially at large PT), also considering the lower target polarization degree”.

Fig. 21: It is hard to believe that the kinematic dependence is so flat for the case of ND3 (as compared, e.g. to the NH3 case shown in fig. 20). Add references for all these plots.

740: “30 days” -> “60 days”

742: “90 days” -> “120 days”

743: “Figure 25 shows ALL for cos(phiR) modulation” -> “Figure 25 shows the projected statistical uncertainties for the ALL cos(phiR) modulation”. Explain in the text that no model has been used for these projections, so only the expected statistical uncertainties are shown (at least this seems to be the case). Otherwise, make it clear the model predictions are consistent with zero.

Fig.25: “Projection of the cos(phiR) modulation of ALL” -> “Projected statistical uncertainties for the ALL cos(phiR) modulation”

Tables X, XI and XII: drop the third column (with all zeroes) and substitute in the caption “projections” with “projected statistical uncertainties”

752: “The third column is the value of the asymmetry” add (based on the comments above): “(only reported in Tables VI-IX)”

Table VI and onward: We don’t fully get the point of giving the projected precision for different days when the number of days is now fixed (i.e. those of RG-C). Maybe just highlight in bold case the column corresponding to the real assigned beam-time (120 days for NH3, 60 days for ND3).

775-777: “We attempted … HERMES [65]” remove this part, since redundant with 768-769, and anticipate/rephrase “these number only serve as an illustration of the possible magnitude of the systematic uncertainties” to line 769, before “for a more accurate…”

784-786: Only the uncertainties affecting the beam/target polarization and the dilution are “scale uncertainties”, i.e. they affect the value of the asymmetry amplitude by some percentages. The other sources (acceptance, resonances, etc.) are not scale uncertainties and should be treated separately and not added in quadrature to the former.

808: “The proposed experiment” -> “The proposed measurement” or “The proposed analysis”. Again, this is not a new experiment proposal, but just an RG-C addition!

834: Remove “with a total of 208 days of beam time”

837-839: “however, it would be nice to have more beam time for a deuteron target…. polarization” This appears as a “hidden” (and qualitative) request to the PAC for more beam time. As discussed in the general comments above, the PAC cannot modify a previously approved beam-time.

840-841: “All of the proposed measurements in this document can be performed with a 3He target as well.” See general comment above. You could try to reformulate as follows: “combining with he He3 data we will have the same statistical precision of NH3…”

Remove Table XIV (and its reference on the text), or quote explicitly that the 120 days for NH3 plus 60 days for ND3 + 5 days for 15N have already been allocated for RG-C.

Minor comments/suggestions on the text (in addition to those from round1)

471: “which is the main focus of our proposal” -> “which is the kinematic region of most interest for our proposal”

528: “can be found in references including [144-146]” -> “can be found in [144-146]”

528-529: “It will be polarized” -> “The target is polarized”

536: “This technique typically achieves” -> “This technique typically allows to achieve”

539: “are the superconducting magnet to provide a strong (5 T) field” -> “are a superconducting magnet providing a 5T field”

544: “Ammonia (NH3) and deuterated ammonia (ND3) as target materialS”. Then skip “with the electron beam and CLAS12“.

592-593: remove “(the fraction …. total)”. The dilution factor is already defined in 545

613: “to select on the” -> “to select the”

615: “to be in the scaling regime” -> “to select the DIS regime”

620: “to get above” -> either “to stay above” or “to get rid of”

622: “for track reconstruction efficiency” -> “to ensure high track reconstruction efficiency”

eq. (94) change comma with dot after the formula.

Add full stop after eq. (96)

643: “from equation 5” -> “from eq. (5)”

647 and 652: “target helicity” -> “target helicity state”

663: “figure 16, the open-triangle points, is” -> “figure 16 (open-triangles) is”

664: “sin(2phiR), is included in the figure and is” -> “sin(2phiR), included in the figure, is”

665: rephrase as: “this twist-2 modulation includes a convolution of…”

675: “than what was shown from CLAS6 in figure 16” -> “than the CLAS6 measurement in figure 6”

Fig. 18: full stop missing at the end of the caption

Fig. 19: “asymmetry. From [161]” -> “asymmetry [161].”

695: “from equation” -> “through equation”

Table IV: full stop missing at the end of the caption.

709: “are shown in figures 20-22” add “as a function of the relevant kinematic variables”

713: It is not the target that is submitted to the PAC48, but rather an experimental proposal based on this target. Rephrase.

722: “will be a bit” -> “to be a bit”

725: “:=” -> “=”

Fig. 24. caption: “versus x” -> “versus Mh”

766: “and cancel” -> “and largely cancel”