Measurements of $\gamma_v p \rightarrow p \pi^+\pi^-$ cross section with the CLAS detector for 0.4 GeV^2 < Q^2 < 1.0 GeV^2 and 1.3 GeV < W < 1.825 GeV

G.V. Fedotov, A. Skorodumina, V.D. Burkert, R.W. Gothe, K. Hicks, V.I. Mokeev, and CLAS Collaboration

Comments from the Ad Hoc Committee (W. Armstrong, N. Markov, M. Ripani – chair)

Overall Comments

All committee members agree that the text needs many improvements in terms of wording and in the way results are organized and presented, in order to match the quality of the paper with the quality and impact of the results.

Numbers below refer to lines in the paper.

Comments by Whit Armstrong

Overall Comments

The data analysis behind this paper is very clear and the results are of high quality. As a whole, the content presented in the paper is complete, however, the writing needs *significant work*. The excellent analysis and results deserve an equally high quality presentation.

There were far too many grammatical corrections and improvements for me to note all of them. Here I just make a few comments in addition to the specific comments below.

1. Many grammar and writing issues need to be addressed. Many sentences and paragraphs need to be restructured. Much of the text is phrased in a way that might be OK for an "analysis note" but is insufficient or too informal for publication.

2. Keep consistent naming, e.g., "Fig."->"FIG." in the text. Also (I could be wrong) I don't think references can be referred to by just the citation, i.e., no "Ref" is needed: "Ref. [1]" -> "[1]"

3. A significant amount of editing and proof reading is needed before publication.

Some minor things:

* "kinematical" -> "kinematic"

* "systematical" -> "systematic"

* For equations with text sub/super scripts, use "\text" (e.g.,M_{left}).

* Remove white space around figures with "clip,trim=L B R T"

* Use "FIG. X" (as it is in the captions) everywhere.

Specific Comments

Introduction:

12: The first paragraph is weak.

26: "Numerical results" aren't these experimental results ?

Paragraph at 53: I suggest moving much of this "physics motivation" to the first or second paragraphs in the introduction. Then move on to discuss previous experiments, and ending with the current experiment. Currently it is written in the opposite order.

Experimental Setup:

FIG. 1: This figure is of very poor quality. Everything is too small. A diagram might help in addition to photographs.

100: "The experimental configuration for the current" -> "The CLAS magnet configuration...". It is not clear what current means.

100: This whole paragraph seems not well structured.

131, 146: Be consistent in naming. "Fig. 2" -> "FIG. 2"

Exclusive reaction event selection

159: "To reveal..." Passive voice sentence.

FIG. 3: Axes font is too small. (compare with FIG. 4 which is OK)

FIG. 4: Caption is poorly worded. I would avoid saying "efficient enough".

204: The single photoelectron peak isn't "so-called". In this paragraph are you referring to the pions producing a signal in the Cherenkov or is this really uncorrelated (not the same PMT as pion)?

Paragraph at 211: What is small and large "relative noise"?

487: What is this paragraph really trying to say? "The reconstructed data and Monte Carlo events were identically binned." Isn't that enough?

Cross Section Calculation

Overall, the discussion of variables and binning needs significant rework.

493: "Kinematical Variables" -> "Kinematic Variables"

516: "must be used" -> Really? Why? Are you sure it "must be used" shouldn't be something like "is easier and conventionally calculated in the c.m frame"?

523: Don't use an itemized list here; keep it in paragraph form.

536: The formatting of this list is messy. May try more a standard thing: (i) enumerate the text in the paragraph, (ii) you can use Roman numerals, (iii) or lowercase letters.

FIG. 13: remove the extra white space below the figure. (use the includegraphics[...,trim=0mm 10mm 0mm 0mm,clip,... option)

TABLE I: The font is too small. Also the table layout is not too good. Try something that looks like this (note that there are no vertical lines)

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---------------------------------------------

                Number of bins

  W range        M   \theta   \phi   \alpha

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 1.3-1.35 GeV      8     6      5      5

 1.3-1.35 GeV      8     6      5      5

 1.3-1.35 GeV      8     6      5      5
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1.3-1.35 GeV 8 6 5 5

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593: Why take the central value and correct when you could use the average values of all kinematic variables for each bin? In this way you would report the bin limits and the average kinematic variable's values.

Equation 12: Drop the ";" at the end and use commas with an oxford comma and an "and" before the fully integrated cross section which logically should be a separate equation from the others.

FIG. 15: Remove white space and increase figure size.

693: Maybe use "uncertainty" instead of "error", here and in the next few paragraphs.

792: "Systematical" -> "Systematic"

### Experimental Results in comparison with the model and previously available data

This section title should be simplified. Maybe "Comparisons with Experimental Results"

FIG. 18: This is an example of a graph that should share axes on a grid, which will allow you to make things bigger. The y and x ranges are all identical and thereis room to move the annotated Q2 values into each frame.

### Conclusions and Outlooks

955: "are presented." -> "were reported."

973: Is the first sentence telling us anything?

980: Remove "that allowed".

### APPENDIX
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FIG. 22: Text is too small. Need to enlarge figure.

Comments by Nikolay Markov

A. The text of the paper has to be proofread.
B. The novelty and importance of the results can be emphasized more clearly.
C. Could you put more details about the physics you are aiming at? Both introduction and conclusion, what are you looking for and how exactly your data will help.

32 : The cross sections were extracted via the CLAS data analysis. Could you clarify?

Fig. 1 Figure is not very clear. One can hardly read captions within the figure.

90 "toroidal magnetic field including mini torus coil" – could you clarify sentence?

106 "non-signal events" – what is it?

129 you talk about beam offset without explaining what it is.

159 you need DC in order to calculate sampling fraction.

252 TOF system provides timing information for tracks, T.

256 you are talking about TOF paddels without introducing them.

392 you introduce DAQ livetime without explanation. The whole "Quality Check cut" part is full of technical details.

501 - 519 do we need such a detailed explanation of the frames of references?

Page 9, Binning and kinematical coverage. The discussion of binning in invariant mass is very important but slightly confusing as of now. Can possibly adding an illustration from the data make it more clear?

Page 9, Binning and kinematical coverage. Is it possible to add a sample plot with angular coverage in one of the topologies?

Chapter 4, subchapters B, C, D: you mention two different event generators, TWOPEG and GENEV, with different models (JM15 and JM05) which are seemingly used for different purposes. Could you use the same generator everywhere?

Fig 16. On your plot of the cross sections angular dependence (Fig. 16) one can see error bars only at extreme points over angles. Moreover, there are no error bars visible when you do not use contribution from empty cell.

Fig. 18 Is rather hard to read, TWOPEG predictions are completely shadowed by the data points. Systematical uncertainty is presented twice, in the error bars and the black band.

Barn symbol is *b*, not *bn*.

Fig 21. Is rather hard to read, symbols overlaps.

In your comparison with the model you compare full cross sections with the TWOPED results and get the resonance part from the JM. Why you do not get the full results from the JM?

Comments by Marco Ripani

26 - This sentence could be placed in a footnote, keeping the reference [2]

50 - It is true that a different averaging makes the comparison less meaningful, but nevertheless such a comparison should be shown as further reassurance that old and new data are compatible

56 - "resonance manifestation" --> "resonances above the Delta(1232)" or "resonances above the first excitation region"

67 - "has proven itself" --> "has proven effective"

80 - "with masses up to 1.8125 GeV" --> there is no need here to give such a precise value, 1.81 GeV can suffice

89 "Electromagnetic Calorimeter" --> "sampling Electromagnetic Calorimeter"

100-102 "The experimental configuration for the current, called "e1e" dataset was the following. The torus current was 2250 A and the mini torus current 5995 A." --> There is no need to give this data here, as they are not very meaningful to the reader. You can just say something like "The torus field setting was such as to bend electrons away from the beamline (outbending configuration)."

108-117 This is a detailed and unnecessarily long explanation. You can just say that "In order to avoid bubble formation due to the specific e1e experimental conditions, the target had a special conical shape that allowed draining the bubbles away from the beam interaction region."

129 "non-signal" --> "background"

134 "corresponded" --> "corresponding"

145 "in Fig. 2, events" --> "in Fig. 2: events"

174-176 "the deposited.....(P_e')," --> "by design the energy deposited in the active scintillators E_tot is about 1/3 of its momentum P_e'," Remember above we added the specification "sampling" calorimeter, so its composition should be rather obvious, although the showering part may be different from lead. But here it is irrelevant.

181-182 "since.....sheets" --> remove, based on the above sentence it is not necessary anymore

196 "below than that" --> "below that"

206-207 and 213-214 It is said that the CC spectrum shows a "so-called single photoelectron peak, which was actually located at a few photoelectrons." but then it is said that the noise results in a "very pronounced single photoelectron peak". Is it one or a few photoelectrons ? You should be consistent here.

211-228 All the text here is somewhat confusing. One thing is the single or few photoelectron noise, the other is that low-efficiency regions feature a photoelectron distribution which is shifted towards zero and therefore adds up to the "single" or "few" photoelectron region. The whole paragraph should be replaced by

something like "Signals from inefficient Cherenkov regions are depleted of good events, as shown in Fig. 4 (the inefficient area in the middle of a sector was expected since two CC mirrors were joined there). Therefore appropriate fiducial cuts were developed to exclude those regions from the analysis".
Also, it is not clear why the distribution shown in Fig. 4 should be specific to e1e, in what sense ?
Finally, it would be better to be more quantitative as to the criteria to define an efficienct vs an inefficient. So, the final two sentences in the paragraph should read as something like "The curves which are superimposed on the distribution show an overall fiducial cut that is applied in the CC plane. Then, within that overall cut, for both experimental data and Monte Carlo simulation, only electron candidates that originated from black regions within the fiducial cut were analyzed, where the black regions are defined as those having an average photoelectron number greater than ?????". The latter definition could be repeated in the caption of Fig. 4.
Question, where the requirements (I guess described in [10]) of matching between track and geometrical PMT position, as well as time coincidence between CC, TOF and EC hit applied here ? If not, why ? Were they applied, thus leading to Fig. 5 ?

231 "presented" --> "present"

263 "corresponded" --> "corresponding"

265 "corresponded" --> "corresponding"

278-280 "To cure that e
ect, a special procedure to correct the timing information provided by the TOF was used." --> "A special procedure was developed to correct the timing information for the affected paddles."

329-335 "However, in order to avoid shifts in distributions of some kinematical quantities (e.g. missing masses) from their expected values, an energy loss correction was applied to the proton momentum magnitude (both experimental and reconstructed Monte Carlo), since the low-energetic protons were a ected the most by energy loss in materials." --> "However, the Monte Carlo cannot perfectly describe all materials in the detector assembly and this could impact in particular the low-energetic protons that are affected the most by energy loss in materials. Therefore, in order to correct the shifts of specific missing mass distributions from their expected values, an energy loss correction was applied to the proton momentum magnitude (both experimental and reconstructed Monte Carlo)"

Fig. 7, legend --> "befor" --> "before"

345-353 "Moreover, the edges of the detection area do not provide a safe region for particle registration, being affected by rescattering from the coils, field distortions, and similar effects. Therefore it is now a common practice to consider only those particles that were found in "safe" areas inside specific fiducial cuts, i.e. cuts on the kinematic variables (momentum and angles) of each particle. These cuts were applied for both real events and Monte Carlo reconstructed events." --> "Moreover, the edges of the detection area, being affected by rescattering from the coils, field distortions, and similar effects were excluded from the analysis by applying specific cuts on the kinematic variables (momentum and angles) of each particle. These cuts were applied for both real events and Monte Carlo reconstructed events."

354-356 According the a comment above, the torus setting should have been already described before. No need to repeat it here. "For that type of particles," --> "For negative, outbending particles (pions in this case), "

360-361 "CLAS sector one in one slice over particle momentum" --> "CLAS sector 1 in a specific momentum slice" sounds better

362-365 "The solid black curves correspond to the applied fiducial cuts. These cuts isolate the regions with a relatively stable yield of events along the azimuthal angle." --> "The solid black curves correspond to the applied fiducial cuts, that select the regions with a relatively flat particle density along the azimuthal angle."

371 "with a relatively stable event yield along" --> "with a relatively flat particle density along"

394 "the FC charge updated" --> "the FC charge was updated"

Fig. 11, middle and bottom plots are interchanged in the caption. BTW, the middle plot (inclusive, right ?) shows a kind of double structure, any idea about what is causing this effect ? Here you should show the ratio in middle and bottom plot as points as a function of block number, with their statistical error, which gives a much better idea of whether the event rate is regular and about where to cut. Moreover axis labels and numerical labels are too big, with some overlapping. On the x axis, the tick marks corresponding to the numerical labels are not visible.

424 "to acquire only about 10% of that." --> "to account only for about 10% of the total."

433 "Electrons, being very light and rapid," --> Electrons, having generally a very high momentum,"

472 "corresponded" --> "corresponding". Same in Fig. 12 caption. Moreover, the panels in Fig. 12 have too big axis labels and numerical labels, with some overlapping. On the x axis, the tick marks corresponding to the numerical labels are not visible.

499 "y_lab - up" --> "y_lab - pointing upwards with respect to the Hall floor"

505 "virtual photon" --> "virtual photon exchanged in the scattering"

after 558 (why do line numbers disappear in this portion of text ?) "distribution depend" --> "distributions depend"; "and the assumed W" --> "and W"

Eqn. 11 Where is the photoelectron correction factor F_ph.el. ? And here the efficiency correction from the Monte Carlo is called with the same letter F. It would be better to show explicitly the factor F_ph.el. and use a different name for the Monte Carlo efficiency

658 "GENEV which assumes" --> "GENEV assumes"

661-667 It would have been better to choose for Fig. 12 a kinematic bin where some of the 3 pion background was visible on the bottom panel

Fig. 16. The top-left legend with the W and Q^2 bin was drawn with a too small font, you should increase the font size

729-730 "pronounceable" --> "pronounced"

732-733 "To account for the possible discrepancies with the model," --> "To account for the model-dependence"

734 "was assigned with a 50 %" --> "was assigned a 50 %"

740-741 "which accounts the radiative" --> "which accounts for the radiative"

748 "colliniarly" --> "collinearly"

760 remove the comma after "electroproduction"

Formula (16) there is an extra bracket) after delta_F

794-795 "from the several sources" --> "from several sources"

800 "was revealed" --> "was found"

Section G. Wasn't any systematic error assigned to the differential cross sections ? The paper only mentions systematic errors on the integral cross sections and there is comment/explanation as to why no such error was calculated for the differential ones. A few words of explanation are in order.

Fig. 19 There are no errors on the data points, while there is an error on the corresponding W point in Fig. 18....

861 "It aims at extracting of the resonance" --> "It aims at extracting the resonance"

908 "high laying" --> "high lying"

958-960 "The results were obtained.....in a kinematical region that lacked information on double-pion cross sections" --> as said a few lines after, there is overlap with both Ref. [3] and Ref. [4], so this statement should be modified. You should say something like "The results, improve significantly previously available data in this kinematic region either by extending the W coverage or by increasing statistics, thereby achieving a finer binning in Q^2 (0.05 GeV^2), "

Other things:

- Replace everywhere "sector one" with "sector 1"
- Same when you describe the topologies, everywhere in the text replace "topology one" with "topology 1" etc.
- It seems me that we typically talk about "systematic errors" rather than "systematical errors" but perhaps they are both valid english expressions, not sure
- Ref. [9] Egian --> Egiyan