



## CLAS PAC52 Jeopardy Review Committee

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# 1 RG\_A

## 1.1 Scientific Impact of the Experiment(s).

**Is there any new information that would affect the scientific importance or impact of the Experiment(s) since originally proposed?**

RG\_A foresees a very broad physics case: it encompasses 13 experiments that have been grouped into six topic categories addressing complementary aspects of non-perturbative QCD. The scientific relevance of each of the experiments has been very well detailed and in most cases CLAS experiments play a unique role in the world scenario.

In some cases, such as the search for exotic mesons, the collaboration with the Joint Physics Analysis Center (JPAC) has provided new tools for the interpretation of the prospected results, making the interest in the physics topics even stronger.

Being the first run group to take data with the CLAS12 detector, RG\_A has also produced seven published papers, mainly on single spin asymmetries from deep processes, using the existing statistics. The results prove the high impact of the scientific program.

## 1.2 Assigned beam time and experiment rating

**Any request for the remaining beam time allocation and experiment PAC ratings to be reconsidered?**

RG\_A has requested the remaining beam time allocation to be assigned with no rating to be reconsidered.

While it is difficult to prove that a factor two in the statistics drastically changes the quality of the expected results, it is also true that since the first data taking in spring 2018 the CLAS collaboration has dramatically improved the understanding of the detector response and has learned how to optimize its performances, including the possibility of increasing the experiment luminosity. The new data are expected to show improved momentum resolution and higher accumulated charge for a beam time allocation which is comparable to the collected one, allowing to expand the physics reach of the final results.

## 1.3 Allocated beam time: collected statistics and data analysis.

*If the Experiment has already received a portion of its allocated beam time and/or is on the presently published accelerator schedule, the spokespersons should provide an analysis of the existing data set, the projected result for any additional time on the published schedule, and the projected result for the complete data set including all remaining unscheduled time. The goal is to show the physics impact of the respective data sets.*

- **What is the status of the analysis of the collected data? (if any were collected)**

As mentioned, RG\_A has lead the publishing activity with CLAS12. Results on the following physics topics have been reported in PRL and PLB:

- First Measurement of Hard Exclusive  $\pi^-\Delta^{++}$  Electroproduction Beam Spin Asymmetries off the Proton;
- Observation of Correlations Between Spin and Transverse Momenta in Back-to-Back Dihadron Production at CLAS12;
- Multidimensional, High Precision Measurements of Beam Single Spin Asymmetries in Semi-Inclusive  $\pi^+$  Electroproduction off Protons in the Valence Region;
- First-time Measurement of Timelike Compton Scattering
- A Multidimensional Study of the Structure Function Ratio  $\sigma_{LT'}/\sigma_0$  from Hard Exclusive  $\pi^+$  Electroproduction off Protons in the GPD Regime
- Beam Spin Asymmetry Measurements of Deeply Virtual  $\pi^0$  Production with CLAS12
- First CLAS12 Measurement of DVCS Beam-Spin Asymmetries in the Extended Valence Region

The following crucial step is the understanding of CLAS12 detector acceptance to extract absolute cross-sections. Teams at Jefferson Lab, the University of South Carolina, Moscow State University, James Madison University, and the University of Connecticut under the aegis of the CLAS12 Hadron Structure Group are carrying on the extraction of the first extraction of the inclusive electron scattering cross section. This opens the avenue to the extraction of exclusive channels cross sections such as two-pions,  $\eta$  and  $\eta'$  electroproduction.

The following PhD thesis have also been awarded addressing the topic of exotic meson production:

- Matthew Nicol, University of York, Exploring the strong interaction through electroproduction of exotic particles
- Letterio Biondi, University of Messina, Investigation on exclusive beam asymmetry measurements of  $e + p \rightarrow e + p + \pi^0$  process at CLAS12
- Robert Wishart, University of Glasgow, Analysis of three body decays in quasi-real photoproduction

In the deep processes field there is also a substantial effort centered at MIT to extract absolute cross sections. This has produced three Ph.D. theses:

Sangbaek Lee, *Measurement of the Deeply Virtual Compton Scattering Cross Section from the Proton at 10.6 GeV Using the CLAS12 Detector*, MIT Physics Ph.D. thesis September 2022.

Robert Johnston, *Measurement of the Deeply Virtual Neutral Pion Electroproduction Cross Section off the Proton at 10.6 GeV Using the CLAS12 Detector*, MIT Physics Ph.D. thesis, September 2023.

Patrick Moran, *Cross Section Measurement of Deeply Exclusive  $\phi$ -Meson Electroproduction off the Proton at CLAS12*, MIT Physics Ph.D. thesis, February 2024.

An analysis note on DVCS has been produced over a year ago and a draft manuscript is in preparation. An analysis note on DV  $\pi^0$  is being finalized.

- **Any changes/updates of the projected results for the full approved running time?**

The projected results of most of the approved experiments have been assessed and no major change is expected for the full approved running time.

## 1.4 Proposal evaluation

- **Is the overall goal of the run group clearly stated with what each experiment brings?**

The scientific scope and the reach of each experiment is clearly stated. See the **Additional Comments** section for a list of suggestions for minor corrections

- **What is new since the last PAC presentation?**

Since PAC48 Jeopardy in 2020, several data from the first data reconstruction release (the so-called pass-1) have been published, as listed in the previous section.

Moreover crucial improvements in CLAS12 detectors alignment and track reconstruction quality led to a new data reconstruction release (pass-2) which has allowed RG\_A to highlight the *Very Strange Program (E12-11-005A): Photoproduction of the very strangest baryons on a proton* as an additional leading research topic.

The interest of the Principal Investigators in the originally proposed program is vivid, as it is proved by the on-going analyses carried out by PhD students of several Universities.

- **Is the current status in terms of allocated and used PAC beam time given?**

The current status of allocated beam time has been summarized in the executive summary. The allocated beam time has been translated into accumulated charge.

The corresponding accumulated PAC days could be reported more clearly, including the status of the data reconstruction of the various data taking periods.

- **Are any issues with manpower, target, detector inefficiencies, etc... that could affect the goals being addressed?**

No issues have been identified.

## 1.5 Additional Comments

The overall physics case has been well described. An explicit mention to all the published articles from the available data could be useful to stress the high impact of the dataset and the importance of reaching the full statistics.

The following minor corrections of the text are suggested:

- the Executive summary quotes an Appendix, which is not available.
- page 2: spring 2029 should be corrected in spring 2019.
- page3 Deeply Virtual Compton Scattering and Figure 1: a mild tension between the global fit KM15 is mentioned. However the figure shows good agreement with VGG and GK curves, which are not mentioned anywhere in the text.
- figure 2: the reaction channel under study should be mentioned
- page 6: first line of paragraph 1.6 shows a typo in the reaction channel
- page 20: the reference should be included in the bibliography
- page 25: the bibliographical reference [bur00] contains a typo.
- Make sure that all the figures presenting preliminary results do show the preliminary watermark across them.