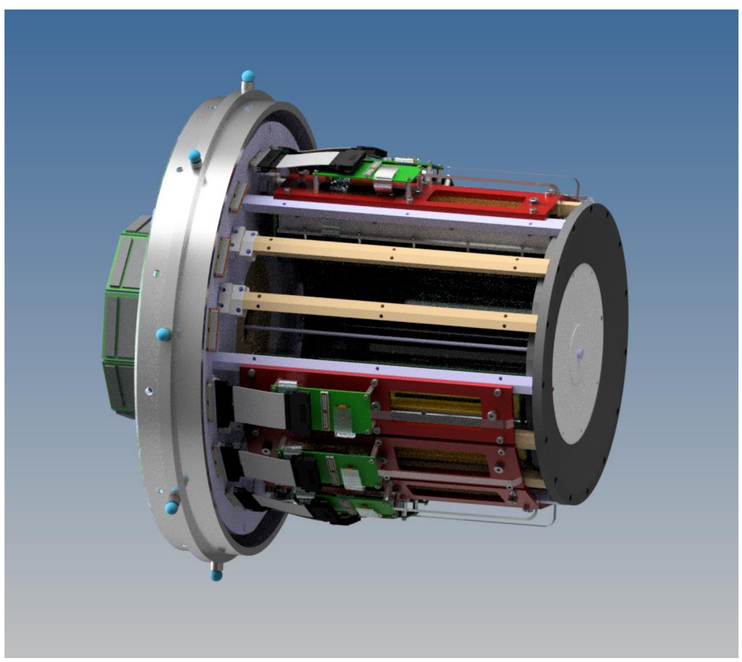
Answer document for the run group L ERR

ALERT group

May 6, 2021

1 Introduction

This document aggregates our answers to the recommendations made during the ERR of the run group L in Hall-B (the ALERT experiments). We make specific answers to each recommendation separately.



2 Recommendation 1: ATOF

2.1 ATOF prototype

Construct a prototype of one TOF wedge (with all four30 cm long scintillator paddles and 40 scintillator wedges) with all the SiPM readouts and associated electronics in place and demonstrate with the expected operating parameters the required timing resolutions.

2.2 ATOF electronics

Prioritize the design of the readout electronics and include a full chain DAQ schematic to show the final front end readout electronics and supporting Hall B DAQ infrastructure.

3 Recommendation 2: AHDC

3.1 Plans for B-field tests

Provide a plan that will demonstrate the operating parameters for the HDC also within a magnetic field.

The ALERT detectors will run in the 5T magnetic field of Hall B. Prior running in Hall B, we plan to bring ALERT detectors in a magnet available at Argonne National Laboratory. The aim of these tests are:

- check the solidity of the detector when travelling as the AHDC will be built at IJCLab, Orsay, France
- check the mechanical behavior of the AHDC components
- check the mechanical behavior of the ATOF components
- check the readout of the AHDC
- check the readout of the ATOF

Planning before being on site:

1. Mounting the AHDC prototype and build its transport box
2. Prepare all the AHDC elements (electronics, computer...) that will be shipped
3. Prepare the magnet (book, HV, LV, crates. . .)
4. Prepare the ATOF

Protocol once on site at Argonne:

1. Transport the AHDC and its electronics to ANL

2. Place the detector in the magnet
3. Connect all the elements: LV, HV, readout, gas
4. Perform checks on the readouts and wait for the chamber to be flushed
5. Turn magnet ON and slowly reach 0.5 T
6. Run with a radioactive source
7. Run with cosmic rays
8. Increase the field and repeat steps 6) and 7) for each step
9. End the tests, dismount the detectors, bring the AHDC elements back to IJCLab
10. Write a report

3.2 Make the tests in January 2022

Implement these tests in January 2022 at Argonne with the partially wired chamber.

4 Recommendation 3: Neutron radiations

Perform realistic estimates to determine the level of neutron radiation at the location of SiPMTs in particular on the downstream end.

Hall-B has recently performed a nuclear target test to measure the amount of neutron radiations around liquid deuterium and helium targets. In this test, detectors were placed in the position of the first and second layer of the CLAS12 SVT, the later being within a centimeter of the position of our SiPMs. The results of this test run are documented in the CLAS12 note 2021-001 [1]. The setup used appear particularly adequate to evaluate the level of radiations to expect on SiPMs for the run group L experiments. By scaling the fluence measured in the test runs to our deuterium and helium runs length and luminosity, we obtain an estimated $2.5 \cdot 10^{10}$ 1 MeV neq cm^{-2}. This estimate was obtained using the measurement from silicon detectors, which was the most defavorable of the results obtained during the test runs (simulations and neutron detectors gave lower results by a factor 2).

See [2] for previous tests performed in Jefferson Lab.

5 Recommendation 4: Analysis Status

Provide a status of the simulation and analysis software with regards to the four experiments of the Run Group L and a timeline for first publication.

We are already well advanced to prepare for the timely analysis of the data after the experiment. As a reminder, there are four main analysis to be made within the run group: coherent helium DVCS, coherent helium DVMP, tagged DIS on helium and deuterium, and tagged DVCS on helium and deuterium. Here is a summary of the different software elements necessary for these analysis.

The simulation is in working order, more refinement are planned to be made in the future. However, in the present stage it can be used for an analysis directly. It already contains a full geometry of both inactive and detector materials; it also contains a reasonable level of digitization to match realistic data. Future improvements are manly to the level of fine tuning the geometry and digitization to better match the precise experimental conditions.

The reconstruction is well advanced and already contains the full geometry, track finding and a basic Kalman filter. The latter is in the process of being finalized in the coming months by Mathieu Ouillon (IJCLab), which also works on the Kalman filter for Bonus12. Thus, we expect this algorithm to be tested against real data before we run the ALERT experiment. Track matching between the AHDC and hits in the ATOF as well as particle identification remain to be implemented. We expect these projects to advance significantly this year and to be completed well before the experiment runs.

The calibration suit is well advanced with the GUI and the ATOF calibration in place. The AHDC calibration is the next important work that we expect to complete this year. Our plan is to have a life size test of these routines with our simulation after this. This work is planned for next year and will complete the preparation of the calibration before we start the experiments.

The event generators used for the proposals will also be used for the analysis. Recently, a new and more realistic event generator has been created for coherent helium DVCS. Similarly, we are developing a new event generator for tagged DVCS, which is expected for this year as well.

In conclusion, we are very much advanced in the production of the analysis software. All elements are planned to be completed well before the experiments starts and be ready for a quick analysis. As of CLAS12 policy, we plan to finish calibration and run reconstruction software 6 months after the end of data taking.

We identified the coherent helium DVCS as the fastest analysis to be performed. The main reasons are that it has already been performed and it requires the least systematic studies. We plan to have this analysis completed within a year of calibration, that is 18 months after the end of data taking. The other analysis require detailed studies of particle identification and backgrounds, we expect them to take 6 months to a year more in analysis. Finally, some side analysis had been proposed, and we expect to data mine the data for several years after that.

6 Recommendation 5: OSP Documentation

Provide the approved OSPs by the time of the operation of the experiment in addition to the standard experimental documentations.

7 Comments

7.1 Drift Chamber

Careful circuit board assembly and board cleaning is crucial to prevent HV leakage or break down to surrounding ground connections.

We are well aware of this issue and we plan to test the boards at every steps of the process to make sure no problem of HV leakage is present.

7.2 Target

Although gas purity levels have been stated as adequate,elimination of any static fill line in favor of dedicated supply and return lines would improve gas purging when switching target gases and inerting the system.

7.3 TOF

The addition of the Nalu readout board is clearly an expansion of scope, and the motivation for it's inclusion was not well defined. The Collaboration should be careful not to allow these developments to adversely impact the timeline for the TOF construction given that current progress appears to be already behind schedule. JLab readout electronics should be available to fully instrument the TOF without the Nalu boards if necessary.

7.4 Software Simulation

The total event size by including ALERT is not expected to be substantially different from normal CLAS12 running, however there appears to be some significant uncertainty in additional reconstruction processing requirements(e.g Tracking). It is important to get amore quantitative estimate of the potential increase in the event processing time for ALERT-based analysis on the farm.

7.5 Radiation levels

The local shielding should be considered around the new high power beam dump to limit the radiation from the dump streaming back into the hall. Model simulations will help.

7.6 ESH

Covers or guards should protect personnel from any energized high voltage conductors. The lab has new requirements for those designated as Qualified Electrical Workers, and new requirements for non-NRTL equipment design & construction.

References

[1] P. Degtiarenko, Y. Gotra, D. Hamlette, M. Kostin, E. Pasyuk, A. Stavola, M. Ungaro, and L. Zana. Nuclear target test report. https://misportal.jlab.org/mis/physics/clas12/viewFile.cfm/2021-001.pdf?documentId=72, 2021.

[2] Yi Qiang, Carl Zorn, Fernando Barbosa, and Elton Smith. Radiation Hardness Tests of SiPMs for the JLab Hall D Barrel Calorimeter. *Nucl. Instrum. Meth. A*, 698:234–241, 2013.