Report on ERR ALERT 2021 April 7

Committee Members:
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Charge:

1. What is the status of the ALERT detector? Please discuss in detail the system design and performance requirements. Also discuss in detail the present status and performances achieved, the completion and commissioning schedule of each component of the detector:
    a. Drift Chamber: "yes" -->"This was covered in sufficient detail."
    b. Target: "yes" -->"This was covered in sufficient detail."
    c. TOF system : "partial" -->"This was not covered in sufficient detail."
2. Has a down selection of the TOF readout electronics been made?
   "partial" -->"This was not covered in sufficient detail."
3. What are the trigger configuration and the DAQ requirements to run the ALERT experiments? Please discuss:
   The ALERT detector is not required to participate in determination of the CLAS12 trigger. It is effectively replacing the CVT detector, but will have a smaller number of total channels and is expected to generate less data than the systems it is replacing.
    a. DC operation and calibration
       A no-field test was done and is under analysis. A test in a magnetic field is planned.
       A commissioning document has been written and operation manuals need to be written.
    b. reconstruction efficiency: not yet established
    c. Readout electronics (what is the event rate that can be handled?) : not shown
    d. Computing requirements: additional 20% cpu time on tracking estimated

4. Have the ESH requirements been considered in the design, fabrication and operation of the equipment, including the pressure vessel design for the gas system?
   Yes - Bill Crahen, who was a Design Authority while at the lab, assisted with pressure system design.
5. What are the requirements to integrate ALERT into CLAS12?
   Support cart based system was presented following the BONUS approach.
6. What is the procedure for changing the different gasses during operation?
   Procedures and expectations were presented.
7. Are the beam commissioning procedures and machine protection systems sufficiently defined for this stage? yes
8. Are the responsibilities for carrying out each job identified, and are the manpower and other resources necessary to complete them on time in place?

Jobs and responsibilities are defined but required resources with path to completion was missing.

9. Are the radiation levels expected to be generated in the hall acceptable? Is any local shielding required to minimize the effects of radiation in the hall equipment?
    a. Yes, the radiation in the hall is expected to be acceptable, defined mostly by the typical CLAS12 luminosity.
    b. 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.
    c. The radiation conditions for the ALERT SiPM sensors need to be numerically evaluated using realistic Monte Carlo simulations. The estimates should demonstrate acceptable levels of the radiation damage to the detectors.
10. What is the simulation and data analysis software status for each experiment? Has readiness for expedient analysis of the data been demonstrated? What is the projected timeline for the first publication? Please provide, if possible, a documented track record from previous experiments.
    a. This topic was not addressed with respect to the four different experiments. Neither was a timeline for expected publications.
11. What is the status of the specific documentation and procedures (COO, ESAD, RSAD, ERG, OSP's, operation manuals, etc.) to run the experiments? Adequate at this time

Findings:

1. Drift Chamber:
   30cm active length, 3026 wires (576 signal + 2450 guard wires), Al 30um diameter, 20deg stereo angle, operating gas He4-CO2 [80%-20%mix] Tested expected load with end plate materials using Al wires and tungsten wires to simulate full load. Test results and deflection matches FEA? HDC test prototype operated with beam at ALTO Facility, Orsay-France.
   The mechanical structures and end-plate machining is complete and tooling for stringing wires has been developed. Tests are planned for B-field testing with a section of the wire chamber and the circuit board interfaces have been completed for connection to the readout[signals] and HV bias.

2. Target:
   The leakage of 4He from the aluminized kapton target vessel was demonstrated with a pressure drop test of <1psi/hour with an initial pressure of 100psi. No visible deformation, sagging or twisting of aluminized kapton spiral wound tube was observed at pressures above the working pressure of the target. Experience with the target and gas system controls for BoNUS12, with the addition of minor improvements, provide the foundation for the ALERT design.
   Hall B Pressure System Design Authority has approved the ALERT system. Operating procedures were presented to ensure required target purity and safe operations. Pressurize and Purge procedures outlined were stated as adequate for ensuring contamination level of target gas below any threshold that would negatively impact data.

3. TOF:
   A “mechanical” mockup of a TOF wedge was presented but not a fully functional wedge as recommended in the past ERR.
   Nice demonstration of ~150ps timing resolution for a ~5.5 MeV alpha in the wedge (which is the “E” scintillator in the deltaE-E configuration). The experimenters say they don’t need such good timing resolution in the bar (which is the “deltaE” scintillator). However, the actual number of pe’s in the bar is of high interest.
   A fair test would be to take a bar (3mm thick), which they have now, and put a SiPMT on both ends with an Am source at the center between the two. A 5 MeV alpha is 193 MeV/c momentum and gets fully stopped in 3mm of plastic scintillator. It would be nice to show that this can be seen by the SiPMTs on both ends and plotting the time difference between the two will give you a measure for the timing resolution and conversely a position resolution.
   The TOF presentation showed readout electronic selections have been made, prototyped and tested. The final configuration includes electronics from Nalu that will be mounted to two TOF ‘wedges’. Systematic crosscheck was given as the reason to instrument two wedges with different electronics, but no details were shown for common Synch and clock signaling.
   The final circuit board layout(s) with the PetiRoc2A chips and Nalu ASIC have not been completed. Integration of TOF readout electronics with the existing CLAS12 DAQ infrastructure was not fully defined.

4. Gas systems:
   Pressure vessel components were specified by JLab DA Bill Crahen. Rupture pressure of the target is stated as ~100 psig which is above the 1.5 safety factor of the working pressure. The target is protected from pressure fluctuations and over pressurization by inline flow restrictor and relief valves set to ~80% of target rupture pressure.
5. Administration:
   Contact persons were listed for each detector element, but details of project activities and personnel that will be assigned the work was not clear. A detailed Gantt chart structure is updated regularly, but this was not shown. Final designs for ATOF and HDC circuit boards *not* finalized.
6. Software/Simulation:
   Detector geometry and detailed signal simulation with digitization was presented in the context of GEMC. Results of track reconstruction were presented. Impact of the ALERT detector material to the CLAS12 downstream track reconstruction was touched but not quantified in detail.
7. Radiation levels:
   The radiation in the hall is expected to be acceptable, defined mostly by the typical CLAS12 luminosity.

Comments:

1. Drift Chamber:
   Careful circuit board assembly and board cleaning is crucial to prevent HV leakage or breakdown to surrounding ground connections.

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.

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.

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 a more quantitative estimate of the potential increase in the event processing time for ALERT-based analysis on the farm.

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.

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.

Recommendations:

1. TOF:
   a. Construct a prototype of one TOF wedge (with all four 30 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.

    b. 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.
2. HDC:
    a. Provide a plan that will demonstrate the operating parameters for the HDC also within a magnetic field.
    b. Implement these tests in January 2022 at Argonne with the partially wired chamber.
3. Perform realistic estimates to determine the level of neutron radiation at the location of SiPMTs in particular on the downstream end.
4. 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.
5. Provide the approved OSPs by the time of the operation of the experiment in addition to the standard experimental documentations.