ND-GAr Design Workshop

January 11-13, 2021

09:30-11:00 CST, 11:30-13:00 CST

Day 1A (January 11, 9:30-11:00 CST)

[09:30-10:15] Overview of systems and interfaces (speaker TBD)
[10:15-11:00] Group discussion of design questions

Known questions, organized by system and (provisional) priority:

1. Mechanical, including HV and gas systems

- Should the TPC have single or double drift volume? What are the considerations for mechanical, HV and gas systems? [including implications for light collection and calibration systems]

- Baseline gas mixture and a few options. Specify requirements. Scintillation light detection (gas mixture and the formation of usable scint light) -- develop concrete R&D plan to narrow down the gas mix options.

- What is the gas purity specification and corresponding flow rate requirement? What is the specification for temperature uniformity? (simulations/calcs, purity requirement will be more strict for a single long drift volume)

- What are the desired calibration systems and how do they interface with other subsystems (field cage, drift electrode, DAQ, etc.)? (ALICE-style vs. sPHENIX-style, needs interfacing with HV system, considerations of single vs. double drift)(simulations needed to help decide?)

- What is the baseline field cage design (consider alternatives such as the more robust sPHENIX style flexible PCB field cage)? Drift electrode HV feedthrough design? What are the implications for these if we go with a single drift volume?

- Should the HV degrader gas volume be separate from the main volume, and a different gas? (Yes: separate volume because of lots of plastic contaminating the “dirty” outer volume) (simulations + archaeology of past measurements)

- What are the boundary conditions for gas safety issues (e.g., what is the maximum allowed amount of CH4)? (DOT spec is <=10%, but lab spec is ~6%.)

- Will we want/need to be able to operate at reduced pressure, and what implications does this have? What is the nominal operating pressure? (discussion, e.g., HV breakdown in buffer gas)

- What is our maximum allowed gas leakage rate for pressure vessel penetrations? (note that GOAT holds pressure without any noticeable leaking, so maybe this is not a concern)

- What is the gas flow scheme? Gas system design (or major components of it)?

- Stray magnetic field in ND-LAr: What are the implications? Are mitigations needed and what could these be?
    - Is stray field in ND-LAr usable for physics (ie, charge determination, momentum analysis at low P, momentum analysis in the region between ND-LAr and ND-GAr)?

- What are the mechanical/structural interfaces between the magnet, ECAL, and TPC; How is the space between them utilized? What are the limitations these systems impose on each other?

2. Electronics, including read-out chambers, cooling and cable plant

- What are the design, R&D and prototyping plans for the Front-end electronics for TPC & ECAL? (LV, signal feedthroughs)

- What is the CROC R&D path, design options? (should we consider GEM amplification in the central region instead of MWPCs?)

- What is the maximum heat load we can tolerate without cooling? With cooling? Or rather, what do we expect the TPC & ECAL electronics heat load to be, and what is the resulting cooling requirement? (if cooling is accomplished via gas flow, how do the requirements differ for 10atm vs 1atm gas)

- Do we need a model for getting data off the detector and through DAQ?

- Correspondingly, what are the anticipated cable counts for the various systems and the corresponding number of feedthroughs/penetrations into the pressure vessel? Can we devise a provisional cable plant design that accounts for the positioning of the barrel and endcap ECAL modules? (discussion + calculation)

3. Simulations and Physics Studies

- Should the TPC have single or double drift volume? [simulations/physics, implications for light collection and calibration systems]

- What is missing from GArSoft to be able to do all the kinds of studies that reviewers keep asking? (Drift velocities, diffusion, attachment, realistic magnetic field, non-uniform E field and temps, B-E alignment, ExB effects, etc.)

- What is the drift field specification? What is the lowest drift field we can tolerate? (sim/reco studies)

- What studies need to be done to further optimize ECAL design?

- What are the desired calibration systems and how do they interface with other subsystems? (krypton, gamma source, ALICE-style vs. sPHENIX-style, needs interfacing with HV system, considerations of single vs. double drift)(simulations to help decide?)

Day 1B (January 11, 11:30-13:00 CST)

[11:30-12:30] Continued group discussion of design questions
[12:30-13:00] Organize workshop attendees into groups and prioritize questions for each group to focus on during Day 2 (groups: **M**echanical [including structure, materials, high voltage and gas system issues], **E**lectronics [including front/back ends, cooling, slow control], **S**imulation & Physics Studies)

Day 2A (January 12, 09:30-11:00 CST)

Mechanical Group (discuss questions M1, M2, …) + light
Electronics Group (discuss questions E1, E2, …)
Simulations Group (discuss questions S1, S2, …)

Day 2B (January 12, 11:30-13:00 CST)

[11:30-12:00] Mechanical Group verbal update (15 min + 15 min questions/discussion)
[12:00-12:30] Electronics Group verbal update (15 min + 15 min questions/discussion)
[12:30-13:00] Simulations Group verbal update (15 min + 15 min questions/discussion)

Day 3A (January 13, 09:30-11:00 CST)

Mechanical Group (continued discussion of “M” questions)
Electronics Group (continued discussion of “E” questions)
Simulations Group (continued discussion of “S” questions) + light?

Day 3B (January 13, 11:30-13:00 CST)

[11:30-11:45] Mechanical Group verbal update (10 min + 5)
[11:45-12:00] Electronics Group verbal update (10 min + 5)

[12:00-12:15] Simulations Group verbal update (10 min + 5)
[12:15-13:00] Full group discussion

- Summarize resolved questions
- Make list of action items for remaining questions
- Discuss timelines and funding scenarios