Charge

The Committee is requested to review the ProtoDUNE-DP Time Projection Chamber technical design, including the CRP, drift cage, cathode, high voltage, frontend electronics, photon system, DAQ and slow control and determine if it is at a satisfactory level for NP02 ProtoDUNE operation at the CERN Neutrino Platform in 2018.

In particular, the review team is asked to address the following questions:

1. Does the TPC design meet the requirements for ProtoDUNE-DP? Are the requirements/justifications sufficiently complete and clear?

Yes. The requirements of the ProtoduneDP TPC have been recently stated in dune docb 2765. Although they have not been discussed explicitly in the review presentations, the design presented is likely to meet the objective requirements.

2. Does the documentation of the technical design provide sufficiently comprehensive analysis and justification for the design adopted and a good pathway to DUNE?

Partly. The mechanical design seems complete; it has not been adequately captured in the documentation for reviewers. Some aspects of the electrical design have been thoroughly addressed but the overall design is not yet complete. The CRP, electronics, architecture of DAQ, field cage and HV feedthrough are a good pathway to DUNE. The cathode will need a reconsideration.

3. Are the TPC risks for ProtoDUNE-DP captured and is there a plan for managing and mitigating these risks?

There is no formal process for managing/mitigating risks. A static list has been shown at the committee request. There was no presentation on this topic.

4. Does the ProtoDUNE-DP design lead to a reasonable production schedule, including QA/QC, transport, installation and commissioning that will enable operation before LS2?

Yes. The production schedule seems well planned and sensible QA/QC plans have been presented. The installation plan is well developed. The safety approval will have to be planned in a timely fashion.

5. Are the drawings sufficiently complete to initiate production? Are potential vendors identified? Is the installation plan sufficiently far advanced to assure that the detector can be installed as designed? Is the design for the installation tooling adequate?

Yes. The procurement and production plans are sufficiently far advanced to assure that the detector can be installed as designed. The installation tools seem adequate but the access plans during installation in the cryostat should be reviewed with CERN.

6. Are all internal interfaces between detector components (CRP, Drift Cage, Cathode, HV, photon system, slow control, frontend electronics, DAQ, trigger and online farm) and cryostat documented, clearly identified and complete?

Partly. Most of the interfaces between detector components are understood. The interfaces between detector and cryostat, including the cable trays in the corners, beam plug, closure of the TCO, possible attachments to the bottom membrane and grounding, need to be clarified, agreed upon and documented.

7. Is the TPC 3D model, top level assembly drawings, detail/part drawings and the material and process specifications documented and sufficiently complete to demonstrate that the design can be constructed and installed?

We cannot answer this question directly. Most top level assembly drawings, detail/part drawings and the material and process specifications were not made available. The presentations indicate that an adequate level of detail has been achieved.

8. Is the grounding and shielding of the TPC understood and adequate?

Partly. The general scheme has been presented and the AC distribution and detector "isolated" ground will follow ProtoduneSP as documented in DUNE docdb 879. Important details on HV distribution have not been finalized.

9. Is the HV system design comprehensive? Are appropriate safety concerns incorporated into the design? Are the design radii, surface finish, cleanliness and QC standards of the components adequate to support operation at the design HV?
Partly. The top level design of the HV has been presented. As mentioned, important details on HV distribution, some of which have safety aspects, have not been finalized. It would be beneficial to describe the cleanliness program and surface cleanliness requirements.

10. Are operation conditions (loads, movement and temperature) listed, understood and comprehensive?
Not yet, although the experiment understands what will be needed for getting operation clearance at CERN. The experiment will benefit from producing as complete a list as possible and submitting it in a timely way to the relevant CERN authorities.

11. Is the TPC quality assurance, quality control and test plan adequate? Have applicable lessons-learned from previous LArTPC devices been documented and implemented into the QA plan?
The plans presented are adequate and reflect prior experience. It is unfortunate that the information from the 3x1x1 prototype, particularly the performance of the LEMs, is not available. This represents a clear risk and the collaboration needs to develop and present a strategy to deal with this situation.

CRP, electronics, DAQ

Recommendations

1. List the project requirements (CRP, FEE, DAQ) and indicate how well they are being met by the present design (traffic light table sufficient); the table could indicate if met by design or additionally by testing.
2. Consider if alpha source testing could be done during acceptance testing of every LEM module so that operating and maximum allowable voltages can determined accurately before installation.
3. A cleanliness program should be defined and it should be verified that the proposed assembly sequence meets its requirements - many particulates produced during installation will end up being captured at the liquid surface by the extraction grid combs.
4. Consider protecting the CRPs with a removable film after their installation.
5. Develop a tension verification system for the extraction grid wires to ensure that these are as designed and to avoid wires breaking with cooling as this would jeopardize the operation of the whole experiment.
6. Test the long-term creep of the brazed extraction grid wires and consider a secondary solder point to prevent detachment.

Photon Detection System, Slow Control

Recommendations

1. The use of a cryogenic glue to anchor the PMT is advisable and we encourage the collaboration to consider this possibility. This includes tests and, if needed, a modification of the design of the PMT holders
2. The specifications for the maximum weights and torque of the cable tray have to be calculated to properly dimension the PMT and Slow control cabling
3. The possibility to perform thickness tests after the TPB coating employing ICARUS facilities at Padova should be investigated.

HV, Field Cage, Cathode

Recommendations

1. Establish a consistent electric field threshold to all subsystems
2. Perform a detailed 3D FEA of the E field near the bottom of the HVFT degrader and its interconnect to the cathode frame.
3. Increase the radius of curvature on the rectangular tube on the cathode frame
4. Provide more data to demonstrate the utility of the degrader rings. (From the presentation, while reducing fields over a large region, they seem to produce a higher peak field)
5. Ensure a safe /redundant grounding of the field-cage circuit.