**Design Review of SBND Field Cage**

 **October 25, 2016**

Committee Members:

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**Executive Summary**

**Specific Comments and Recommendations**

Report Terminology

Findings are statements of fact that summarize noteworthy information presented during the review.

Comments are judgment statements about the facts presented during the review. The reviewers' comments are based on their experiences and expertise. The comments are to be evaluated by the project team and actions taken as deemed appropriate.

Recommendations are statements of actions that should be addressed by the project team. A response to the recommendation is expected and that the actions taken would be reported on during future reviews.

**Findings:**

Progress on the design of SBND's field cage was presented including its mechanical and electrical components as well as plans for its production and quality assurance. The option chosen is one similar to that being used for the DUNE Single Phase detector and has benefited from simulations, FE analysis, and prototypes in common with protoDUNE. The modular design using roll-formed proflies is chosen in SBND mitigates the labor intensive stainless steel tube design used in other LArTPC's (e.g. MicroBooNE and ICARUS) as well as allows for mechanical and electrically independent modules to be fabricated and assembled. Small scale high voltage tests have shown this design to be electrically robust. Detailed electrical simulations have shown the uniformity of the field is sufficient to satisfy the physics requirements of the experiment.

**Comments:**

Inclusion of visual inspection of the plastic caps at the end of the field cage rings should be in the Quality Assurance given the electrical importance of the caps.

Work with the engineering and design teams should continue to ensure the correct labeling of the single line diagrams (distinguishing east/west, upstream/downstream) should continue.

A more complete plan of the connection from the Cathode Plane Assembly (CPA) to the Field Cage should be made with the consideration of using a copper bracket instead of a wire connection.

Diagonal cross-bracing needed for the swinging door (in the event that entry into the TPC is needed post installation) should be included in the existing design

Inclusion of rapid cooling of the resistor divider board (“cold shocking”), should be done as part of the QA plan

**Recommendations:**

The committee recommends keeping as much overlap between the design and assembly team as possible to help with the necessary transfer of knowledge and to help mitigate QA/QC risks. Integration of the electrical team into the assembly and installation should be done at all steps of the design, assembly and installation.

The details of the needed supplies, procedures, and personal in the event that the field cage should have to be accessed following installation into the cryostat should be given in advance to help make any such emergency procedure go as smoothly as possible.

Detector physics studies at various E-fields may require 3 varistors in the design of the resistor divider board. The current design includes 2 varistors giving a maximum voltage drop between rings of 3.4 kV. A final discussion with the collaboration should clarify this detail.

**Answers to Charge Questions**

1. Are the technical specifications adequately defined? Does the design meet the specifications?

**Yes, the technical specifications are well defined, inclusion of the field requirements for the ullage region should be included. The simulation and small scale tests suggest the current design does meet the specifications**

1. Are engineering analyses including electrostatic and structural FEAs sufficiently comprehensive to support the design?

**The current engineering analyses does appear to be comprehensive enough to support the design**

1. Have key technical and safety risks captured?  Is there a plan for managing and mitigating these risks?

**An open question remains to the assembly procedure and how the components will manage stresses during transport. The key technical and safety risks and mitigations for the HV and electrical contacts do appear well met.**

1. Are interface and integration issues of the field cage to other detector components identified and adequately addressed?

**Most interfaces and integration issues are well addressed in the current plan. The pick-off point needs to be analyzed (source meters, functionality, etc…) in more detail and where the filter board associated with the pick-off point will be located (minimizing the wire length of unshielded wire)**

1. Are the component layout and fabrication drawings, assembly and installation procedures sufficiently complete to support the fabrication, installation and operation of the subsystems?

**Assembly procedure at FNAL needs to be developed with the team at FNAL. The review provided enough information to get started and continued cooperation will allow for a successful assembly. The method of removal of panels in the case of repair after installation should be clarified.**

1. Are the designs presented sufficient enough to support the start of filed cage fabrication?

 **Fabrication drawings are needed, but the design appears solid**

**Appendix A: Charge to Reviewers**

  **Design Review of Field Cage for SBND**

**October 25, 2016**

 Charge

The Committee is to conduct a technical review of  SBND stainless steel roll-formed field cage design to assess its readiness for fabrication.  Field cage is part of the high voltage system to provide a draft filed of 500V/cm with 1% uniformity in the TPC drift volume while keeping electrical field everywhere else below 30KV/cm.  The review team is asked to examine the design and address the following questions:

* Are the technical specifications adequately defined?  Does the design meet the specifications?
* Are engineering analyses including electrostatic and structural FEAs sufficiently comprehensive to support the design?
* Have key technical and safety risks captured?  Is there a plan for managing and mitigating these risks?
* Are interface and integration issues of the field cage to other detector components identified and adequately addressed?
* Are the component layout and fabrication drawings, assembly and installation procedures sufficiently complete to support the fabrication, installation and operation of the subsystems?
* Are the designs presented sufficient enough to support the start of filed cage fabrication?

The committee should present its findings, comments, and recommendations as well as answers to the above questions in a written report within 2 weeks of the actual review.

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