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| SBND TPC Technical Review Committee Report |
|   |
| 28-29 September 2015 |

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1. Introduction

An Independent Technical Assessment of Short Baseline Near Detector sub-systems was held on 28, 29 September 2015. The sub-systems examined were: the design of TPC components, the assembly and installation of the TPC, and the design for the TPC electronics and readout. Independent Technical Assessments are held to provide input on the technical status to laboratory oversight reviews which focus more on cost, schedule and management. The charge holds specific questions to be addressed as part of the Assessment, and is included in Appendix A. This document holds the committee’s Assessment Report.

Reports from assessments or reviews are broken down into three basic sections.

The first section holds the committee’s summary and opinions of the presented material. These committee viewpoints are generally organized under headings called **Findings**, **Comments** and **Recommendations**. Findings are a summary of the presented material, as the committee understood it. Comments are what the committee thinks about the presented material, based on their experience and expertise – these can be concerns, opinions, or acknowledge agreement with the presented material. Findings and Comments tend to go hand-in-hand; if the committee has a Comment on a particular item, then there should be a corresponding Finding which outlines what the committee believes it was told. Recommendations are statements of actions which the committee believes the presenters should carry out. A Recommendation indicates a higher level of response from the technical team than a Finding which reflects a concern. The committee can list several Findings and no Recommendations if they feel there are no serious issues.

The last section of the report is the appendices; these contain reference materials for this review. The Charge for this review is given in Appendix A, and the agenda is in Appendix B. The committee who conducted this Assessment is listed in Appendix C.

The SBN Program maintains a tabulation of all Technical Assessment recommendations and the responses to them. The tabulation is presented to Laboratory Management generally through periodic Director’s Progress Reviews but may also be presented at other oversight meetings as requested.

1. TPC Components
	1. Design Overview

The review scope included only the design of the TPC, TPC assembly and installation and readout. However, some details regarding interfaces with other systems differed from presentation to presentation. Specifically, the cryostat top and the photon detection systems have impact on the mechanical designs of the TPC, APA frames, location of feed throughs, cable supports and strain relief, etc.

* 1. APA Frame

Findings

* The flatness tolerances for production of the anode plane assemblies (APA) are extremely tight (±0.5mm over 4m). Companies surveyed that might make these assemblies have quoted their achievable tolerances to be considerably looser than the specifications.
* APA design calls for +/-0.5mm flatness across full length of the 4m frame, and most vendors seem unable/unwilling to achieve this specification. The company closest to the spec was still only able to promise +/-2mm flatness; the others would only promise between 15 and 30mm.
* Since surveyed fabrication companies do not seem to be willing/able to meet the desired frame flatness spec it has been decided that the wire frame flatness would be achieved by adding levelling bars to the design.
* No plan for alignment/survey of the wire planes was presented.
* The FEA of the frame showed very small Y and Z deflections and a relatively large X deflection (0.9mm) but the X deflection appeared to be a rigid body rotation around one end of the APA. If the APA were completely free to rotate that way, the calculation would have failed so there must be some constraint - but it may not be what was intended.

Comments

* Leveling bars were added after the initial APA design phase. It may be possible to relax the fabrication tolerance of +/-0.5mm on the APA frame if the required tolerance on planarity of the wire planes can instead be achieved with the use of leveling bars. This may also offer cost savings in the frame fabrication.
* It was stated that no machining would be done to the surface of the levelling bars. This is important since cold rolled steel is being used and, due to surface stresses, CRS is likely to warp if the surface is machined off.
* One might consider a modification to the design that includes welding a plate to the box-beam where the geometry circuit boards attach to the assembly. This plate may then be machined to the flatness tolerances needed.
* The flatness spec of the APAs requires an acceptance criteria for each of the assemblies. Ideas for fixtures to measure the APA flatness are under discussion. Unless the APA are within the flatness spec quoted, the geometry boards will require shimming.
* Soliciting input from the Fermilab Metrology group during the design phase is encouraged. They may have suggestions for techniques to make it easier to level the wire planes during installation, and/or additions and changes that would make the final survey of the planarity easier.

Recommendations

* Look into why the company promising +/-2mm is so different from the others. Are they believable? Or, are the other companies just being overly cautious?
* Survey additional companies for the manufacture of the APA frame and attempt to identify manufacturers that have the capability to manufacture the frames within spec. Solicit recommendations from candidate companies about achieving the flatness spec.
* Consider relaxing the flatness spec. Pursue the backup plans of leveling bars and/or shimming the geometry boards that define the wire planes.
* Develop flatness measuring tooling for the APAs. This tooling should be used to:
	+ 1. Ensure the flatness spec is met for each APA frame
	+ 2. Measure flatness deviation to develop a shimming plan for the geometry boards that define the wire planes.
* A hand calculation shows the deflection of the frame under its own weight when supported at the ends would be roughly 0.5mm. This is not a problem since the APA will be used vertically. It is important however that the group is clear about what they mean by flatness and have defined a reference support condition for measuring flatness.
* Reexamine the loading and constraint conditions in the FEA of the APA frame. Make sure they are realistic and accurately reflect the actual loading and constraint.
	1. CPA Frame

Findings

* CPA mechanical design and construction procedure well advanced. Two options (cathode optically transparent or with PCB reflector) are both compatible with presented CPA design. Design compliant with electric field limitations. Connection with HV feed-through defined. Planarity properties under investigation.
* The CPA frame design makes use of wire mesh to create an optically transparent cathode plane. Stretched mesh is captured by a retainer ring.

Comments

* CPA surface is made of a somewhat coarse mesh with sharp ends. This is normally not good for a high voltage part as it can lead to discharge but in this case the ends are covered by retainer plates to eliminate this problem. The wires themselves were not thought to be small enough to cause problems.
* Wire meshes are difficult to make flat. Extra care will need to be taken to ensure that edges of mesh do not protrude past edges of retainer ring.
* The metal frame of the CPA in DUNE was found to have enough capacitance that damage could be done to electrical components if there were an accidental discharge. It was stated that this is not a concern here since voltages are lower and the frames are smaller so less charge is stored.
* Integration of CPA into TPC cage still under development. Suspension scheme still at concept stage. Decision on cathode options can be postponed to the construction phase.
* It is good that the tolerance on flatness has been relaxed as compared to the MicroBooNE value of +/-0.5mm.

Recommendations

* To fully define the design of CPA, complete investigation on planarity and integration with TPC cage.
* Develop procedures for stretching mesh over frame and for QA of finished product to eliminate possibility of sharp/frayed edges.
	1. High Voltage Feed-through

Findings

* Design heavily relying on several similar realizations (ICARUS, MicroBooNE, DM experiments). Maximum HV easily at reach with same technology.
* Electric field requirements for HV FT claim 40 kV/cm, but other TPC elements are designed to 30 kV/cm.
* Detailed design (e.g., dimensions) can only be finalized after cryostat dimensions are finalized. Cost and schedule are also not yet defined.
* Prototype designs are in progress, but not yet completed or tested. Two groups are working on this: UCL and Yale.
* Monitoring and diagnostic tools are not yet developed.

Comments

* HV FT is probably not a critical path item, but cost and schedule should be understood sooner rather than later.

Recommendations

* Extensive HV tests at cryogenic temperature are mandatory on constructed feed-throughs. Involved labs are well equipped for this activity.
* Single electric field requirement should apply to all detector elements, including HV FT.
* Prototypes must be tested extensively in pure, non-boiling LAr. Rather than building new facilities (e.g., at Yale), consider using existing cryogenic HV testing facilities at Fermilab and/or CERN.
	1. Field Cage

Findings

* At least two alternative design options for the construction of the field cage are available. The reference design is based on PCB technique on FR4 foils supported by insulating beams. It follows closely the design realized for the 35 ton prototype at FNAL. The second is based on open rolled form metallic profiles as under development for the future DUNE detectors. This will be tested on a dedicated test set-up. For both alternatives, very detailed studies of electrode shapes and spacing have been performed aiming at limiting electric field intensities below the critical value that could induce discharges. Voltage resistive degrader has been complemented with surge suppressors (varistors) to prevent field distortions in case of resistor failure.
* The field cage reference design is a PCB-based field cage supported by FRP I-beams, similar to the DUNE 35-ton TPC. The alternative design is made with roll-formed metallic profiles, which appears more robust and may offer significant cost savings. The alternative roll-formed profile field cage has the benefit that a door can be designed to allow easy access into the TPC interior.
* The field cage reference design has brackets that connect the field cage to the APAs and CPAs, shown on page 9 of Bo Yu’s presentation. This design is similar to the MicroBooNE I-beam to anode plane connection.

Comments

* The alternative field cage option with roll-formed profiles is very attractive, especially if the endcap design for corners is shown to work in the CERN test. However, if the endcap design does not work, then a corner-bending technique (as in the reference design) will need to be developed.
* Both solutions present pro and cons in terms of cost, weight, robustness, ease of assembly, etc… Final choice will depend heavily on results of dedicated prototyping that is still under preparation.
* The increased potential for high voltage discharge if a piece of solder mask chips off is a shortcoming of baseline design.
* C2: The Field Cage – I-beam connections (brackets) have the potential for interference of the brackets with the motherboards attached to the APAs. This same interference existed in MicroBooNE (of similar design) and caused mechanical constraints that limited the range of adjustment possible during leveling of the wire planes.

Recommendations

* Pursue alternate design. Make this baseline when appropriate.
* Clearly prototyping studies are on the critical path. A back-up solution based on a more classical implementation of the field cage with electrodes made of metallic tube rings (as in MicroBooNE and ICARUS) should be kept available.
* Whichever field cage design is chosen, a method for entering the TPC interior should be required.
* (This maybe should be a recommendation for interfaces between field cage and cold electronics). The motherboard/field-cage-bracket design interfaces should be carefully coordinated. The possibility of mechanical interferences should be eliminated, either by modifying bracket design, or by modifying motherboard design, or both.
	1. APA Wire Winding

Findings

* The wiring configuration for the APA is well defined with basic parameters identical to those of MicroBoone (# of wire planes, wire spacing and orientation, thickness, wire material, wire bonding). Diagnostics for wire tension measurement identified but still under development. Implementation of the new concept of “electron diverter” to recover dead space at the joining of two APA’s is proposed.
* Two approaches to wire winding (manual and semi-automatic) are being pursued at two different laboratories. The wire pitch and spacing are identical to MicroBooNE, and the geometry boards have an improved design over the similar MicroBooNE wire carrier boards. Each of these facilities will develop wire placement machines, fixtures and procedures. The precision with which the wires are placed affect the reconstruction of physics quantities.

Comments

* The UK wire winder design shows a wire placement head with a small radius tip. If the wire is pulled over a small radius wheel in that tip it is likely that some curl will be introduced into the wire. Although it may be pulled straight under tension some wavi-ness could persist and it could make the wire harder to handle.
* Wire tension measurement devices/procedures appear to be at an early stage.
* The use of two different approaches (a manual one and a semi-automatic one) in two different laboratories aiming at similar quality and precision ensures a safer approach to APA wire stretching. Design of the wiring system detailed procedures and the associated quality measurements and controls are still in a early stage.
* Geometry boards have an improved design, with centered full-circle through holes for alignment pins, rather than the MicroBooNE design with half-circles cut out on both edges of a wire carrier board. Nonetheless, the possibility for minor misalignments exists if PCB “sandwich” for the three wire planes is not carefully constructed. Tolerances on the MicroBooNE wire carrier boards appear to be reasonable, and misalignments are thought to have arisen during manufacture and/or assembly.

Recommendations

* Develop tests and fixtures to qualify the precision of the wire placement for each facility. The tests and fixtures should be common between the two facilities.
* Develop apparatus for measuring the anode wire tension to be used at both wire placement facilities and for use as spot checking APAs as they arrive for TPC final assembly.
* The timeline proposed by the collaboration for prototyping, construction and assembly of both the wiring tooling and the quality monitoring systems has to be strictly followed.
* Tight quality assurance and quality control procedures should be put in place to avoid the minor overlaps and misalignments that may occur between adjacent geometry boards.
1. TPC Assembly and Installation
	1. TPC Assembly Process

Findings

* Assembly is responsible for keeping TPC elements (inter-element, not alignment within a component such as wires within a single APA) in proper position and relative alignment.
* Placing rods diagonally across the APAs looks like a good way to support the inside edges of the APAs. This allows a smaller number of supports at the top of the TPC. This should help with the development of a support system that will not be adversely affected by changes of size during cooling (as well as fulfill the stated goal of supporting the TPC near the outside edge of the cryostat roof).
* 1” diameter rods seem like overkill in this situation but it’s a small amount of material relative to the rest of the TPC. If it simplifies design or fabrication sufficiently it may be the right choice.
* The tension of this rod is out of the plane of the APA. This has the potential to distort the APA. It was pointed out that the other side of the APA has large off-center loads due to the wire tension and the frame is sufficiently rigid to carry them without excessive deflection.

The means of installing the jumper interconnection needs to be examined to make sure it will work. The jumpers can be put in after the APAs are connected to each other if there is enough room or with the help of a special tool. As an alternative, the jumpers might be installed before drawing the APAs completely together.

* Preliminary plans were presented for assembly of the TPC and installation TPC assembly into the cryostat. Details of these plans will depend critically on the design of the cryostat top.
* At this early stage of the project no plans were presented to inspect/qualify parts for the final assembly of the TPC. Damage in transportation is possible for several components.

Comments

* Assembling the APAs flat and rotating them to an upright position after assembly sounds like the right approach.
* It was stated that stops were going to be added to the frame (or the PD system) to keep the PD system from being inserted too far into the frame and damaging the APA mesh. This is a good idea and should be implemented.
* It was stated that as much assembly of the APAs as possible was going to be completed before the APAs were rotated into an upright position – including cabling. This is a good idea.
* Cabling and electronics boards will be mounted to the APA assembly before rotation. Consideration of how cables are managed during the rotation and subsequent movements needs to be considered.
* Initial meetings with FNAL Metrology group may prove useful while developing assembly procedures.
* Preliminary designs for the cryostat and cryostat top are needed to proceed further with plans for attaching the TPC to the cryostat top.
* Plans were outlined to produce scale models of the TPC components and assembly fixtures to help understand aspects of the TPC assembly. While these will be very useful, they may not identify problems in working with the full size components.
* Plans were presented to attach the cryostat top in the D-Zero Assembly Building, but it was noted at the time that the clearances to get the TPC with top out of the building were tight. It is likely that the depth of the cryostat top will only grow with more complete designs.

Recommendations

* The engineers should satisfy themselves that the diagonal tension members will not cause warping of the APA.
* Schedule meetings with alignment/metrology group to identify areas where their input may help inform procedures.
* Plan to perform full sized tests of assembly steps, ideally in the space to be used for the final assembly. This may require development of mock ups of various components.
* Develop inspection/qualification plans/tests for components before they are assembled into the TPC. Similar tests of the electronics and final cabling should be included prior to the TPC installation into the cryostat.
* Develop plans for attaching the cryostat top outside of the D-Zero Assembly building.
	1. TPC Installation and Integration

Findings

* The transfer of the TPC from the transport frame itself to the cryostat lid sitting on the transport frame was complex. It sounded like this had been thought out satisfactorily but the process should be double checked to make sure that the load can be suspended simultaneously from both. This will ensure that there is no danger of a support point being unsupported at any time during the transfer.
* Overall cleanliness requirements should be examined with respect to assembly in the detector building. It will not be very clean if it’s an area with an open door for admitting a truck. This may or may not be a problem depending on the cleanliness requirements.

Mounting for light collection system within APA frames is under development, but major installation requirements have been identified (UV light protection scheme during installation, reasonable clearance, etc.). Decision of whether this system will be installed at DAB or at ND building is not yet made.

Rough survey plan has been defined for installation and integration.

Comments

* The plan is to remove a side of the transport frame in the detector building so the TPC and cryo lid can be moved out of the transport frame. If removal of the side of the transport frame will require the crane then the transport frame with TPC and lid has to be able to stand on its own with only 3 sides attached - or, another crane will be required to support the TPC and lid at the same time the frame side is removed.
* Is there enough clearance that the TPC can be lowered into the cryostat without someone standing and watching from an unsafe position (under the hanging crane load)?
* Extra tapped inserts on the APA frame could be advantageous for manipulations such as transferring the load from above to the transport frame.
* The light collection system design was not presented, so it is difficult to see where interferences or difficulties might arise with integration or installation.
* The plans for TPC installation appear to require attachment of the cold electronics and cables between the electronics and the feed throughs prior to installation of the TPC in the cryostat. Details of where this critical step occurs should be fleshed out.

Recommendations

* Review the process of transferring the TPC from being supported directly by the transport frame to being supported by the cryostat lid. Make sure the two sets of supports don’t interfere with each other and that no part of the TPC is ever unsupported.
* Determine how the TPC will be brought from the assembly building to the detector building and then unloaded and installed while maintaining adequate cleanliness.
* Check the process of removing the TPC from the transport frame at the detector building to make sure that it can be done with a single crane (or that a second is available if needed).
* Careful communication between light detection system and TPC is encouraged, particularly in final design stages for LDS, where interfaces for installation and assembly will be critical.
* Set up meetings with FNAL survey/alignment group to identify which parts of detector will need as-found survey vs. alignment help during assembly and installation.
1. Electronics and Readout
	1. Cold Electronics Design

Findings

The TPC electronics was presented starting with an accurate overview of the TPC and how the electronics is integrated onto the detector itself. Starting from the cold electronics basic components also the signal feed throughs, with a few options, were presented until the warm electronics interface. To serve the 11,264 sense wires the ASICs (FE and ADC) are mounted on 88 front end (FEMB) mother boards. The proposed ASIC FE is a revised version of the existing ASIC with many improvements namely in I/O protections and driving capability. Also calibration system has been improved. This sounds a very good feature even if in operation the most precise calibration will be obtained by cosmic rays analysis. The final silicon run for ASIC production will be late summer 2016. The test system was presented based on a test board that can test four ASICs at the time. The test boards will be ready on time with the first ASIC production. Detailed illustration of prototype boards and even PCB layouts were included in the presentation.

Plans for electronics development include provisions for multiple revisions of specific boards. Aside from the testing and electrical performance, qualification of those boards but numbers of boards. Plans for distributing various revisions of these boards for use in developing the interfaces for the data acquisition and slow monitoring were not presented.

Plans for testing and qualifying the front-end (cold) readout boards exist at the design and boar assembly stage. Plans for similar testing and qualification of other boards were not presented.

Comments

* The review was supposed to be made on a detector proposed for the SBN experiment that has a rather tight time schedule. However, we are in front to a very accurate presentation on issues that are still requiring a dedicated R&D program. Namely the following issues are still requiring validation: (1) ADC will require extensive validation in the 35 ton setup, and this should be compatible with required timescale; (2) reliability of the analogue front-end and its control seems to be an issue.
* Development of boards with computer/communication should include testing of software interfaces.  These tests should be performed by the groups developing those interfaces and their integration with the data acquisition and slow control/monitoring.

Recommendations

* The main argument to adopt double flanges seems to be the issue of argon gas purity possibly impaired by a less than one meter length cables. Anyway the SBND has in argon gas phase a sizable amount of components that could be a source of pollution that will require recirculation in any case, in accordance with the results form other liquid argon TPC. In this perspective double flanges look as an overhead that could be a source of extra problems rather than a solution. The statement that double flange would relax tightness requirements ignores the back-diffusion effect that will allow oxygen contamination, even if reduces, that will limit electron lifetime. Not to mention the increased costs and number of connections that will be at least doubled.
* In general the mechanics of the cold electronics (connectors, mezzanine boards, piggy-back etc.) looks rather complex and the number of connections (see also the previous recommendation) are a potential cause of failures.
* A plan for board revision should be developed including additional boards from early revisions for testing by the data acquisition and slow monitoring groups.
* Bring the plans for testing and qualification of all circuit boards to the same level.
	1. Warm Electronics and Trigger Design

Findings

The general architecture was presented in a convincing manner. In fact this design is based on sound experience maturated in other experiments. The conceptual design of the warm electronics is completed and the detailed design is ongoing.

Comments

* In the perspective that digital conversion and preliminary data handling is made successfully inside the detector (cold electronics) the task of the warm electronics is even less demanding.

Recommendations

* The trigger strategy is well known and defined however the hardware implementation is not yet fully defined. In an liquid argon detector the light signal must play a fundamental role and this issue has not been described in any phase of this review.
	1. Electronics and Readout Infrastructure

Findings

General layout of the detector hall, including mains connections and distribution, was presented and follows guidelines already successfully implemented in larger liquid argon TPC operated.

Ideas and concepts were presented for monitoring and controlling power supplies for front end electronics. Many of these concepts make use of experience from previous experiments and tests such as MicroBoone and the 35 ton Dune prototype. However, the detector control systems seems to be missing.

Comments

* The team responsible of the infrastructure is aware of the different problems concerning these issue and for its reputation deserves confidence.

Recommendations

* The guidelines, with special reference to the grounding layout, should be carefully implemented.
* A dedicated group should be established to design and implement a slow controls and monitoring system.
	1. Data Acquisition Overview

Findings

Clear and extensive presentation of DAQ requirements was done, starting from information gathered from different detector parts (TPC/PMT/CRT) up to the conversion of the files in a format compatible with LArSoft.

Comments

The system embeds all the necessary controls as monitoring, data managements, quality management and processing. Taking into account data from about 11,000 wires compression à la MicroBooNE the DAQ is designed to sustain bursts up to 450MB/s. PMT are quoted but no PMT system was ever presented. DAQ design is adaptation of previous design for which a lot of experience exists. SBND design will make use of fiber optics in place of previous multiple copper links. New boards and backplanes will be produced.

Recommendations

A coordination effort is required for compatibility of programming languages used in different sections of DAQ. MicrobooNE experience is recognized to be a reference. The hardware implied is listed in detail. The list of people involved was also presented together with technical labor support from institutions/ Design reviews of board documentation (schematic, layout, manuals,..) is always a good idea. The project should decide at what level to require this review.

1. Charge Questions
	1. TPC Components
2. Are the detector performance requirements clearly stated and derived from the SBND scientific requirements? Do the TPC detector component design parameters follow from the performance requirements?

*Yes. Performance requirements appear to come from scientific requirements and design seems appropriate to give those performance requirements.*

1. The APA frame, the CPA and field cage parts, and the related connecting/supporting structures - are at an advanced preliminary design level.
	1. Have engineering analyses been performed, and do they show that the relevant technical parameters are being met by the design?

*Yes. The design looks mature in terms of engineering.*

* 1. Have any lessons from MicroBooNE or DUNE 35T TPC design and fabrication experience been utilized for the SBND TPC? There are both similarities and differences between the SBND TPC and the DUNE TPCs; is there a listing of potential synergies where the two designs might learn from each other?

*The 35T project has helped with the design of SBND in many ways. There is an ongoing effort to develop synergies.*

* 1. Are the designs for each of these components ready to move to the final detailing design stage?

*Yes. There is no reason to delay start of the final detailed design.*

1. Are the anode wire-winding plans at a reasonable level of detail, given the desired timeline for delivery of completed wound anode planes? Does the winding plan include adequate prototyping of the apparatus and practice with its usage? Are testing procedures and quality acceptance criteria being developed?

*The APA design appears complete. The winding plans are still preliminary and will require further development and prototyping. That is understood and planned for by collaboration members.*

1. The TPC detector components have interfaces with other systems, such as the cryostat, the readout electronics, and the enclosure. Is there a process, in place or under development, to identify, agree on, and make changes to the interfaces between systems?

*A system for working on interface changes was not presented – though there may be one. Some of the interfaces themselves were presented at the review. It was noted during the review that regular integration meetings are held with stake holders present.*

* 1. TPC Assembly and Installation
1. Are the detector performance requirements clearly stated and derived from the SBND scientific requirements? Do TPC installation parameters (for example, handling or alignment) follow from the performance requirements?

*The performance characteristics were clearly stated. The TPC assembly appears to be at a preliminary design phase while the installation plans are more conceptual. Some details appear to be missing (eg: cleanliness requirements for TPC handling outside of D-Zero).*

1. Is the TPC assembly and integration planning at a reasonable level of detail, given the desired timeline for detector operations?

*Yes. Some of the details of the TPC design have yet to be decided upon. Assembly and installation must wait until details are fleshed out.*

1. Are there any aspects of the assembly and installation plan still under development which might trigger adjustments to the finalized design of the TPC components?

*Yes. Details of the TPC attachment to the cryostat top/lid appear to be in the conceptual design phase. Handling the TPC for attachment to the cryostat top/lid may require additional handling points, either temporary or permanent.*

1. Does the designated assembly space at DAB meet the assembly –phase requirements for materials handling, materials storage, and environmental control?

*Yes, in part. TPC assembly plans at DAB appear to be a little better than “preliminary”. Details of the procedures to attach the TPC to the cryostat top/lid appear to still be at the conceptual phase.*

1. The TPC assembly interfaces with other systems, such as the cryostat, the readout electronics, and the enclosure. Is there a process, in place or under development, to identify, agree on, and make changes to the interfaces between detector systems?

*Yes. It was noted that regular integration meetings are held with all stake holders present. However, different presentations had different details for the cryostat top/lid. Communication could be improved.*

* 1. Electronics and Readout
1. Are the detector performance requirements clearly stated and derived from the SBND scientific requirements? Do the readout electronics design parameters follow from the performance requirements?

*Generally, yes. However, we note that, “Integration, electronics and readout subsystems are still in the preliminary design stage” T. Miao slide 3.*

1. Have any lessons from MicroBooNE or DUNE 35T electronics and readout experience been utilized for the SBND TPC?

*Partially. MicroBooNE has only cold front end, while the SBND pretends to have the full electronics chain, up to digitization, in cold atmosphere. This evolution is not discussed. Some electronics issues from MicroBooNE have yet to be passed on to SBND.*

1. Are there plans for electronics component QA/QC including testing at various design and production stages? Do the readout testing plans include apparatus for testing at intermediate stages during the detector and electronics assembly and installation process?

*Yes, It seems that the QA/QC problem is faced with adequate consciousness.*

1. The TPC readout electronics have interfaces with other systems, such as the cryostat and the enclosure. Is there a process, in place or under development, to identify, agree on, and make changes to the interfaces between detector systems?

*Yes. Regular integration meetings are held with all stake holders nominally present. The general layout is presented by L. Bagby. Electrical and grounding interconnections among different parts of the system are extensively discussed. Details of the cryostat and enclosure interfaces still need to be fleshed out.*

1. Do the preliminary readout/DAQ power, cooling and floor space needs provided for the building design criteria allow for adjustments during finalization of the readout design?

*Yes. The answer is positive taking into account the MicroBooNE experience.*

1. Is there a plan to develop a coordinated facility and detector grounding scheme between SBN and DUNE? Is there a process being developed to ensure the detector grounding is correctly implemented?

*Yes, in part. The review committee does not believe this issue was covered with regard to DUNE. Concerning the grounding the answer was given at point 4).*

1. Appendices
	1. Appendix A - Charge

To: Cat James (Deputy SBN Program Coordinator), Ting Miao (Technical Coordinator for SBND)

From: Peter Wilson (SBN Program Coordinator)

Subject: SBN Independent Technical Assessment of the SBND TPC and TPC Readout

Please organize and conduct a technical assessment of SBND sub-systems, specifically the TPC detector design, the TPC assembly and installation plan, and the TPC readout development plan, to be held in September 2015.

The Short Baseline Neutrino Program will have a Director's Progress Review in November 2015, covering the program’s planning and execution and focusing on scope, cost and schedule, and management. In preparation, a series of technical assessments on the status of the detectors and facilities will be held in the months prior to the Director's Progress Review. Reports from the technical assessments will be provided to the Director's Progress Review as background for the cost and schedule, to demonstrate these are for systems which meet the scientific and technical requirements of the SBN Program.

These SBND sub-system assessments will be held as three sessions on 28-29 of September:

Monday 28 Sep - morning – Preliminary design review TPC construction

Monday 28 Sep - afternoon - TPC detector assembly and installation planning

Tuesday 29 Sep - morning - TPC readout electronics design status, testing and test stand planning, and DAQ interface planning

A detailed agenda will be provided in the days prior to 28 September on a web site, along with links to background materials.

A committee is formed to perform the assessments, using as guidance the questions included below. A committee Chair oversees all three sessions, and specific committee members are asked to focus on one or more of the sub-systems. The committee and assignments are listed below. The committee is asked to submit a report of their assessments within two weeks to the SBN Program Coordinator.

* 1. Appendix B – Agenda







* 1. Appendix C – Review Committee Membership

Sandro Centro

*Full Professor in Fisica Sperimentale, in quiescenza, Dipartmento di Fisica e Astronomia, Universita di Padova*

Sandro has participated in the UA1 experiment where he was responsible for the muon detector upgrade. He was also responsible for electronics and readout of the ICARUS T600. He is presently Deputy of Icarus T600/WA104.

Lee Greenler

*Mechanical Engineer, Physical Sciences Laboratory, University of Wisconsin*

Lee is working on the design and fabrication of the Anode Plane Assemblies (APA) and APA winding equipment for the DUNE project.

Francesco Pietropaolo

*Research Scientist (Primo Ricercantore) INFN (on leave of absence at CERN)*

Francesco has more than 2 decades of experience in liquid argon TPC technology. He has played an active role in the ICARUS experiment from the early R&D stage up to the design, construction and operation of the T600 LAr-TPC at Gran Sasso. He is presently involved in overhauling the T600 detector at CERN for its future operation at FNAL. He has also participated in the design, construction and operation of dark matter experiments based on double phase liquefied noble gas TPCs.

Jennifer Raaf,

*Scientist I, Fermilab*

*Jen is the MicroBooNE TPC Assembly/Installation Manager.*

Russell Rucinski

*Mechanical Engineer IV, Fermilab*

Russ is currently the head of the Mechanical Engineering Department for the Particle Physics Division at Fermilab. He has been working in the field of mechanical engineering for 26 years. He has been involved with the liquid argon TPC design for the past 5 years working on the former LBNE project and is currently the Project Mechanical Engineer for the Far Detector of the DUNE project. For the period 2001-2012 Russ was the group leader of the D-Zero Detector Operations group. During that period and before he had experience with mechanical assembly of detectors and cryogenic systems.

Theresa Shaw

*Electrical Engineer 5, Deputy Head PPD Electrical Engineering Department, Fermilab*

Terry is the project electrical engineer for the DUNE far detector. She has experience with the 35ton liquid argon prototype detector being in instrumented at Fermilab.

Michelle Stancari

*Scientist I, Fermilab*

Michelle has extensive experience in liquid argon TPC R&D, including the Electronics Test Stand at Fermilab and the Liquid Argon Purity Demonstrator (LAPD). She is currently coordinating the 35ton prototype activites for DUNE and is deputy convener of the DUNE TPC working group.

Richard Tesarek (chair)

*Scientist II, Fermilab*

Rick was the deputy project manager for NOvA where he served as installation and integration coordinator for the prototype near detector and integration and commissioning coordinator for the far detector. He has more than 30 years experience in the construction and commissioning large scale detectors. Rick has contributed to the construction and commissioning of NOvA, SciBooNE, CDF (run 2) and KTeV experiments.