TPC Outer Tracker (TPOT) Technical Review
January 26, 2022

Russell Feder, Jack Fried, David Lynn, Venetios Polychronakos, Rahul Sharma, Nikolai Smirnov, Flemming Videbaek*, Bo Yu
*Chair

Executive Summary

The TPC Outer Tracker has made good progress since the first review in September 2021.
There is now a detailed mechanical design and good coordination with the sPHENIX project.
Prototype has been produced but the projected resolution has yet to be demonstrated.
The overall schedule is tight to deliver modules in May 2022, but if no major problems emerge it is on track to be installed at the end of July 2022.

Answers to charge questions

- Are the technical details of the TPOT for installation and integration in sPHENIX sufficiently mature? Yes, pending resolution of analysis of deflections.
- Is the gas system properly understood and at a level of maturity that will ensure safe operation of the TPOT and sPHENIX? Yes.
- Is the schedule of the TPOT sufficiently well understood and matched to the plan for installation in sPHENIX? Yes
- Are the risks introduced by the TPOT upgrade into the successful operation of sPHENIX well understood, and are sufficient plans to mitigate these risks in place? Yes
- Are the interfaces and integration with sPHENIX and RHIC well understood? Yes
- Is the ES&H properly managed? Yes
- Are the costs of the TPOT sufficiently well understood, and are the resource needs required to complete the TPOT upgrade fully identified? Yes for costs, partly for resources.

TPOT design / electronics / gas system (Vinnie/Nikolai/Jack/Bo)

Findings

Progress of TPOT since last review was presented. This included the agreements about scope, distribution of contributions to the descoped project. Technical progress and test results from a first prototype were presented.

The TPOT team plans to test a detector module with zigzag shaped readout strips.

Comments:

The TPOT FEE board cooling design should be assembled and tested in the lab to verify performance. This can be done in the sPHENIX cooling systems lab with the negative pressure rig. Verify the cooling performance and fit up of the cooling board and other features.

The TPOT gas system is reasonably simple and in a good shape. We propose to test the system with Ar/CO2 before being used for the real detectors, and to try to find an option to test gas quality for the gas return line(s).

The design team should measure/model the FEE response to a larger input capacitance expected from the zigzag copper strips, and evaluate its SN Ratio. There is some inherent waviness in point charge reconstruction from zigzag electrodes if the zigzag period is large compared to the size of the charge cloud. This waviness will result in degradation of position resolution so appropriate tests need to be performed to validate the design.

At the earliest opportunity, test a back-to-back double detector module with the planned configuration with readout electronics and full length cables to evaluate the stability and noise performance to avoid the discovery of interference at the last minute.

There are several open issues in regard to what the performance of the final modules will be. Chamber construction should be started when the pre-production module is functional mainly from space resolution, gain, and noise points of view.

There was not too much Information on assembly work, testing of modules , and integration after chambers were delivered to BNL and before the final insertion of the TPOT modules at sPHENIX. We could not evaluate if sufficient resources (work force, space) are available.

The TPOT team has done a good job of categorizing and assigning risk. One issue could be supply chain issues that suddenly result in a vendor not being able to deliver an item, and other covid related delays in module production.

Recommendations

The testing and assembly at BNL is in the schedule, but is lacking details. The team should identify tests, requirements and work force for this activity. Report to NPP by March 31 2022.

…

TPOT integration / installation /schedule (Russ/Rahul/Dave)

Findings

Using the TPC installation structure to install TPOT is a good idea and will help with schedule and cost.

The TPOT team has worked closely with sPHENIX engineering to ensure TPOT is well integrated between EMCAL and TPC.

3 deflection calculations were presented: 1) a base model with only the 80/20 profiles, 2) addition of U channels bonded to the 80/20 profiles, 3) addition of fixed patch panel joints. The deflection of case 1 is 35.5mm, case 2 is 0.11mm, case 3 is 0.01mm.

A clear plan for ES&H was presented for TPOT detector and operation, including dealing with flammable gas.

Comments:

The factor of >300 improvement in deflection by simply adding U channels to the 80/20 profiles seemed optimistic.

An assembly jig can be used to hold the shape of the 3-sector TPOT assembly. Analysis should be performed to check the deflections during lifting for installation.

Alignment markers/Survey targets are missing from the design. Survey plan needs to be developed.

80/20 profiles should be marked clearly after the detector is installed and position of the detectors should be checked periodically to make sure nothing has moved. Alternatively, one mounting hole for each module can be drilled through 80/20 profiles to make sure detectors are precisely located and can't move.

Add the EMCAL picture frames to the general overall view of the 3-sector TPOT assembly so people can get a complete view of the mechanical system. Show how the TPOT 3-sector assembly lands on the tops of the EMCAL frames and how the TPOT is then secured to the frames.

Schedule presented works for sPHENIX construction. The earliest TPOT installation is sometime in late August 22'. The schedule presented by the TPOT team shows TPOT ready for installation in late May 22'. Given all the risks and "unknown unknowns" TPOT should not adjust or extend their schedule and stick to this May delivery.

The team should assess the spare plan to ensure both the TPC and the TPOT have sufficient spares at the end of installation.

Recommendations

The FEA model presented was highly simplified and it was hard to determine if the model and results adequately simulate the actual TPOT build. A more detailed FEA model is needed with an independent check to verify the results. The updated model and results should be available within a month.