

Feedback to IDRC recommendations: TPC R&D status and planning

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On behalf of the working group

June 3, 2026

- Reassess the choice of $500 \times 500 \mu\text{m}^2$ pad size in combination with the T2K gas mixture, as this configuration appears suboptimal for dE/dx-based particle identification.
- Extend the beam-induced background studies, incorporating recent improvements in simulation and mitigation methods to refine background estimates and design margins.
- Conduct more detailed investigations of space-charge distortions, ensuring that correction strategies are validated for all expected running conditions.
- Prototype ion backflow suppression techniques, independently of the selected solution (e.g., double mesh or graphene filter), to verify feasibility and performance.
- Demonstrate experimentally the effectiveness of spark-protection measures for the readout electronics.
- Evaluate CO_2 cooling as a potential alternative to water, taking advantage of its dielectric properties and ability to maintain constant-temperature heat removal without electrical risk.

Plan and Status

Item	execution time	Status
1. Test and validation of readout modules (double mesh Micromegas + high granularity pads)	2026	Finished prototyping and testing of Micromegas, The integration of readout module is almost finished
2. Readout ASIC optimization (including spark-protection measures)	2026-2028	Discussed with Zhi Deng, we will firstly focus on the testing of current ASIC version
3. Prototype ion backflow suppression techniques, independently of the selected solution (e.g., double mesh or graphene filter), to verify feasibility and performance	double mesh : 2026-2027 Graphene: 2026-2028	Performed simulation of IBF suppression with double mesh. The results show staggered arrangement of two meshes can achieve IBF \times gain of about 1 . Preparing for graphene testing with Shandong university
4. Pad size optimization in combination with the optimized gas mixture	2026-2029	Simulation studies has been done to optimize the pad size. Truncated mean shows the optimal pad size is likely in the rage of 200-400 μm by truncated mean, deep learning gives much higher SP with smaller pad size
5. Further studies of beam-induced background (together with Haoyu)	2026-2030	No further progress so far
6. More detailed investigations of space-charge distortions. Calibration and correction strategy studies	2026-2030	Just started investigation of calibration and correction strategy
7. Evaluate CO ₂ cooling as a potential alternative to water, preliminary design and FEA	2026-2027	Discussed with Mechanics expert, the study of CO ₂ will performed together with tracker system. started thermodynamic FEA