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Studies of TPC detector prototype for future lepton collider experiments

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A global community of physicists specializing in Lepton Collider Time Projection Chambers (TPC) is working to realize an exceptional physics program at the energy-frontier, particularly for electron-positron collisions in the International Linear Collier (ILC) and the Circular Electron Positron Collider (CEPC). A large TPC prototype, tested in a 1.0 T magnetic field, accommodates up to seven identical Micro Pattern Gaseous Detector (MPGD) readout modules. This prototype has been studied using a 5 GeV electron beam at DESY. Several successful beam test experiments have measured key performance metrics, such as the drift velocity, spatial resolution, and the dE/dx resolution, using different readout concepts (GEM, Resistive Micromegas and GridPix) with a monolithic cooling plate in 2-phase CO_2.

In the update CEPC Physics and Detector Technology Design Report (TDR), the TPC is described as having a cylindrical drift volume with an inner radius 0.6 m, an outer radius of 1.8 m, and a half-length of 2.9 m. This design significantly enlarges the tracking acceptance (cosθ ~0.98). The TPC can provide up to thousands of 3-D space points, with a single hit resolution of approximately 100 μm in the $r-\phi$ plane. There are two options for the readout structure: pad and pixel, both of which are promising technologies, especially at the high luminosity Z-pole.

In this talk, we will present the track reconstruction performance results and outline the next steps for developing pad/pixelated TPC technology for future lepton colliders.

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