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6. Study on the bias analysis and correction in MPGD μTPC mode

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The μTPC (micro time projection chamber) is a working mode in MPGD which has mm-level gas gap for particle energy deposition. Similar to TPC, the μTPC method measures the signal time of each readout channel and calculates the corresponding drift distance. By reconstructing the track segment in the gas gap, the spatial resolution is significantly better than that of the charge centroid method, when the particle is not vertically incident. However, the μTPC method has a theoretical bias of reconstruction position, which is not easy to get observed in experiments. The induced signal of any readout channel may come from several primary ionized electrons that arrive at the readout plane at different times, but the measured signal time is usually the time of the first electron signal exceeds the energy threshold. When the number of electrons is larger than 1, the measured time is ahead of the real drift time. Thus, most of the measured time of readout channels are ahead of expected, the reconstructed center point of the track segment is also biased. However, this effect is not significant, and the deviation of the bias is related to the detector structure, the electronic system parameters, the gas parameters, and the track incidence angle, which is roughly around 1 times of the spatial resolution, such as 100 μm. In the experiment, this bias is often covered by the alignment deviation. In order to correct this bias, we analyzed the measurement principle of μTPC method, and proposed the correction method based on electron transverse and longitudinal diffusion analysis. Using the initially fitted track incidence angle and the measured charge of readout channel as input, the signal time of each readout channel can be corrected, and more accurate reconstruction performance is obtained. The simulation results show that this method can partially correct the position bias of the track segment mid-point and improve the spatial resolution by about 15% at the same time. The experimental data based on the cylindrical μRGroove detector is also being analyzed, and the preliminary result also presents an improve the μTPC method performance.

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