Development of a GEM tracker for the J-PARC E16 experiment

W. Nakai[*1,*2] for the J-PARC E16 Collaboration

The main aim of the J-PARC E16 experiment is to measure the mass modification of ϕ mesons in nuclear matter at J-PARC in order to study the origin of hadron mass. The details of this experiment are presented in another article of this report[1)].

We employed a tracking detector using the Gas Electron Multiplier (GEM)[2)], and have been developing it to be a position-sensitive detector in a magnetic field with a magnitude of 1.8 T at the center of the magnet. Our requirement for this detector is a position resolution of 100 μm up to an incident angle of 30° in a high counting rate environment of up to 5 kHz/mm^2. Our GEM tracker consists of a drift cathode, triple-GEM stack, and readout strip board. We chose a strip pitch of 350 μm to achieve the required position resolution.

For inclined tracks, a hit position of a GEM tracker is determined with a technique called "timing method", where the spatial distribution of a charge cluster generated by a charged track in the drift gap is reconstructed using the arrival timing information of signals from readout strips. As shown in Fig. 1, the distance from ionization electrons to each strip (z) can be calculated by $v_{\rm d} \times t$, where t is the arrival time and $v_{\rm d}$ is the drift velocity. After calculating each z, we fit a straight line to these points and determine the intersection point of the line with the center of drift gap.

In the experiment, a drift gap of 3 mm is desirable to reduce the signal pile-up; however the test experiment was performed using a wider gap. Thus, additional analysis is performed to evaluate performance for a 3 mm gap. The analysis only uses signals that have smaller drift times corresponding to the 3 mm gap.

Results of this analysis are shown in Fig. 2 and Fig. 3. We tested four types of chambers, which are summarized in Table 1. We have achieved a position resolution better than 100 μm and an efficiency of 90% up to an incident angle of 30° for all sizes of GTRs.

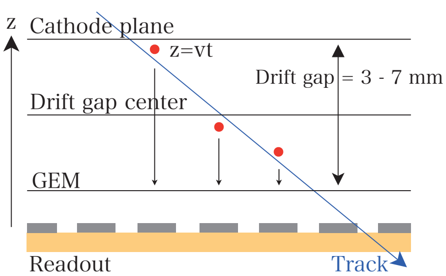

Fig. 1. Positions where ionization electrons are generated can be reconstructed by $v_{\rm d} \times t$.

*1 Department of Physics, The University of Tokyo
*2 RIKEN Nishina Center

Table 1. The summary of tested chambers.

Size	Drift gap	Legend in Fig. 2 & 3
100 mm	7 mm	GTR100 A
100 mm	5 mm	GTR100 B
200 mm	7 mm	GTR200
300 mm	7 mm	GTR300

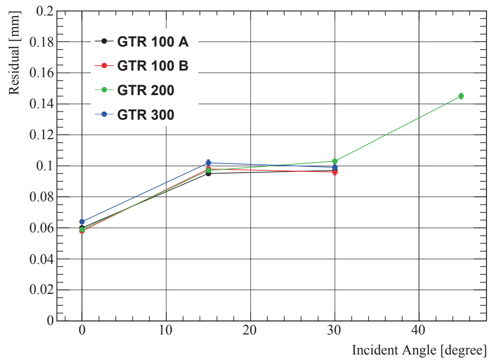

Fig. 2. The result of 3 mm gap equivalent analysis. Standard deviations of residual as functions of incident angle.

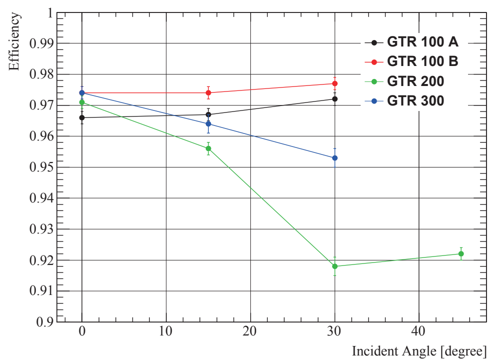

Fig. 3. Detection efficiencies as functions of incident angle.

References
1) S.Yokkaichi, *et al*, in this report
2) F. Sauli, Nucl. Instrum. Meth. A386 (1997) 531