

Development of the tracking detector with large GEM foils for the J-PARC E16 experiment

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The J-PARC E16¹⁾ experiment is proposed to measure the mass spectrum of the ϕ meson in nuclear matter. In the spectrometer, the momentum of charged particles is measured using the tracking detectors(called “GEM trackers”) in a magnetic field. The details of the GEM tracker are described elsewhere²⁾³⁾. The development of the tracker with an effective area of 300 mm × 300 mm is reported in this article. A schematic view of the 300 mm×300 mm readout board is shown in Fig. 1. Cartesian strips called “X” and “Y” are made of copper and patterned on the top and the bottom of a polyimide sheet of thickness 25 μm . For charge sharing between X and Y, the base polyimide is etched using the chemical method, except just under the X strips. The glass epoxy of thickness 100 μm is laid under the Y strips as a support.

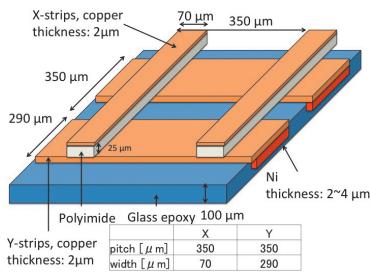


Fig. 1. Schematic view of the 300 mm × 300 mm readout board. Only a part of the readout board is shown in this magnified view.

The positions of the strips were measured using a coordinate measuring machine (Nikon VMR-10080). The coordinates of the cross-points of the left edge of the X strips and the upper edge of the Y strips (x_{ij}, y_{ij}) $_{(i,j=0,\dots,71)}$ were measured for every 12 strips. The subscripts i and j denote the row and column numbers. The deviations of the coordinates of the cross-points from the mean values were calculated for each strip and plotted in Fig. 2. The deviations of the X and Y strips are defined as $x_{i,j} - \sum_{i=0}^{71} x_{i,j}/72$ and $y_{i,j} - \sum_{j=0}^{71} y_{i,j}/72$. The maximum deviation of the X and Y strips were 43 μm and 42 μm , respectively. The deviations were small compared to the spatial resolution of the X and Y strips, which are 100 μm and 400 μm , respectively. The precision of the readout strips was confirmed. GEM foils with an effective area of 300 mm × 300 mm were also fabricated. The average diameters of the holes were 65 μm for copper and 33 μm for polyimide in the top and the middle GEM of the stack,

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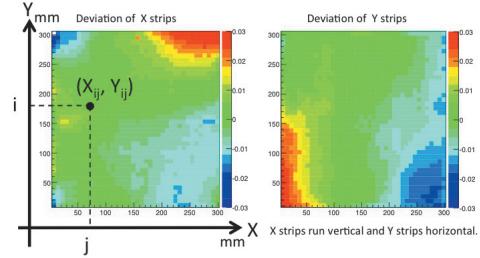


Fig. 2. The measured deviations of the X and Y strips of the 300 mm × 300 mm readout board. The unit of the color bar is mm and the right (up) direction is the positive direction in the left (right) figure.

and 56 μm and 27 μm in the bottom for copper and polyimide, respectively. The spatial resolution of the GEM tracker was evaluated using positron beams at the Research Center for Electron Photon Science, Tohoku University. The setup is shown in the left panel of Fig. 3. The GEM tracker was located between two Silicon Strip Detectors (SSDs). The position resolution was evaluated on the basis of the residual of the hit positions calculated from the hits on SSDs and the GEM tracker. The obtained residual distribution for the 0° beam is shown in the right panel of Fig. 3. The residual distribution was fitted with a Gaussian, and the standard deviation was 73 μm . The requirement of the position resolution is 100 μm , and the 300 mm × 300 mm GEM tracker has sufficient resolution for the experiment.

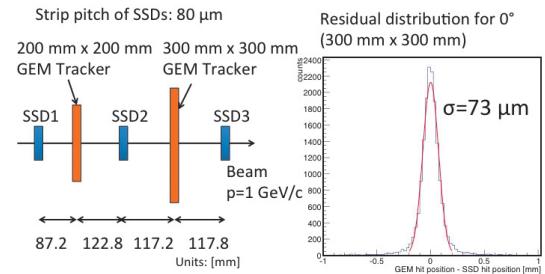


Fig. 3. Setup of the beam test (left) and residual distribution of the 300 mm × 300 mm GEM tracker for 0° beam(right).

References

- 1) S. Yokkaichi et al.: In this report.
- 2) Y. Komatsu et al.: RIKEN Accel. Rep. **45** (2011).
- 3) Y. Komatsu et al.: RIKEN Accel. Rep. **46** (2012).