Construction of GEM Tracker for J-PARC E16 experiment Run0-a

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The J-PARC E16 experiment[1] has started to reveal the relationship between spontaneous chiral symmetry breaking and masses of hadrons. We measure the mass spectrum of the ϕ meson in nuclei using e^+ e^- decays. The momenta of e^+ and e^- are reconstructed from the curvature in a magnetic field; therefore, tracking of the lepton pairs is quite essential. To deal with the expected high-particle rate of 5 kHz/mm^2 and to cover a wide area of 1.1 m^2, we adopted a gas electron multiplier (GEM) as the tracking device. GEM chambers are reported to operate normally even under a 25 kHz/mm^2 particle rate.[2]

We have developed GEM Tracker (GTR), whose GEM foils are manufactured by a Japanese company. Each GEM chamber consists of three different sizes of the chambers; 100 mm × 100 mm (GTR1), 200 mm × 200 mm (GTR2), and 300 mm × 300 mm (GTR3). A GEM chamber consists of three GEM foils and is filled with Ar+CO_2 (70:30) gas. Each chamber enable measuring the positions of charged particles with a resolution of 100 μm.[3] We prepared six modules of GTR for the first commissioning run for E16 (Run0-a) in June 2020. They were placed to cover the same solid acceptance surrounding the target. The process of construction was as follows: In the first step, we selected good GEM foils for stable operation. We measured the leakage current by applying 500-V between the bottom and top electrodes of the GEM foils with a 400 mL/min N_2 gas flow. We required the leakage current to be less than 10 nA/100 cm^2 and the number of discharges to be less than 10/h. The results are summarized in Table 1. After selecting good foils, we assembled them as a GEM chamber. Prior to installation, two steps were performed. First, we tested the chambers for presenting sufficient operation stability and sufficiently high amplification gain of 6000, as required for a position resolution of 100 μm. If there were problems, such as an insufficient gain or impossibility of applying a nominal voltage of 380 V to the GEM electrodes, we disassembled the chamber and exchanged the GEM foils. Second, we transported them to the experimental area, set them on the CFRP frame, as shown in Fig. 1, and tested them again. Here, we checked the operation stability as well as the cable disconnections. Subsequently, we successfully installed the GTR in the spectrometer magnet.

Table 1. Results of leak current test. Approximately 100 GEM foils were checked over 3 months.

size of GEM (mm^2)	good	bad	sum
100 × 100	21	15	36
200 × 200	18	12	30
300 × 300	19	11	30
sum	58	38	96

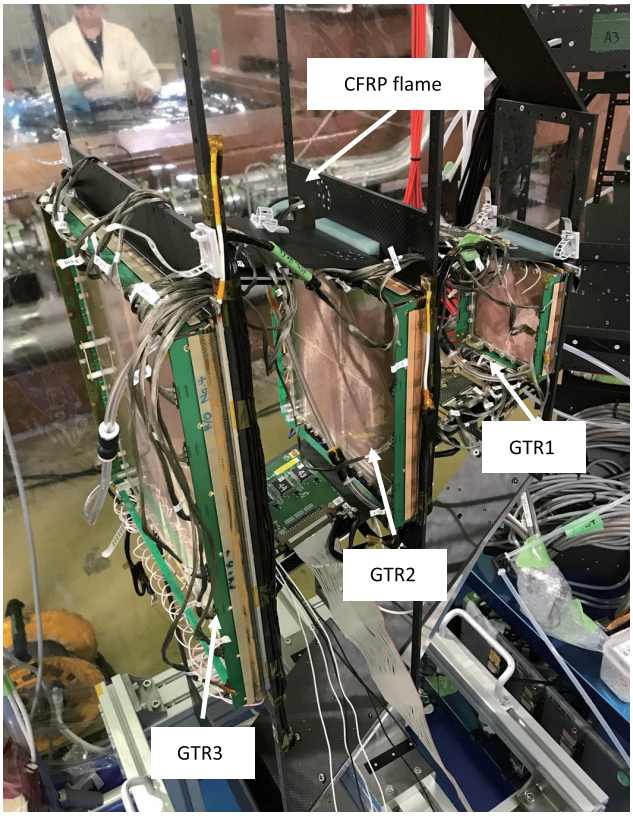

Fig. 1. GEM chambers attached in CFRP frame. This is single module of GTR, and six modules are placed surrounding targets in Run0-a.

References

1) S. Yokkaichi *et al.*, in this report.
2) B. Ketzer *et al.*, Nucl. Instrum. Methods Phys. Res. A **535**, 314 (2004).
3) Y. Komatsu *et al.*, Nucl. Instrum. Methods Phys. Res. A **732**, 241 (2004).

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