A Proton Beam Monitor Based on a Micro Pattern Gaseous Detector Using Glass-GEM

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IV. 1. A Proton Beam Monitor Based on a Micro Pattern Gaseous Detector Using Glass-GEM

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Recently, gas electron multiplier (GEM) technology[1)] has been studied in various fields to develop a new type of a gas detector system and shown significant advantages over a multi-wire proportional chamber such as the excellent special resolution and stable operation at higher counting rate. It is expected that GEM technology meets requirements for monitoring of the scanned-beam parameters in the charged particle therapy.

The aims of this study were to develop a micro-pattern gaseous detector based on GEM technology (GEM detector) as a new transmission beam monitor for charged particle therapy and to assess its feasibility on the basis of a performance test using a proton beam by evaluating two dimensional intensity distribution of the beam.

Figure 1 shows the GEM detector developed in this work. The GEM detector consists of a cathode plate, a glass-GEM plate, and two window foils, and filled with a gas mixture (Ne 90% + CF_4 10%). The advantage of the glass-GEM is higher gas gain compared to conventional GEM using organic substance as a insulator. In this work we used the glass-GEM plate (Hoya CO. LTD., Japan) made of a 680 μm thick glass sandwiched between 9 μm thick cupper electrodes, and has holes in 140 μm in diameter with 280 μm distance. When electrons induced by an incident proton beam are multiplied by the GEM, scintillation is generated from the Ne-CF_4 gas and detected with a CCD camera. It is possible to evaluate a two-dimensional (2D) beam-intensity distribution using the scintillation. The GEM used in this work has an active area of 100×100 mm. The gas gain of the glass-GEM has been checked with X-ray (^{55}Fe) and alpha (^{241}Am) sources (Fig. 2).

In order to evaluate characteristics of the GEM detector for beam monitoring, the experiment was performed using an 80-MeV proton beam provided from the K=110-MeV

AVF cyclotron at CYRIC. The GEM detector was placed in the horizontal irradiation system[2)]. The proton beam from the cyclotron was delivered to the GEM detector. The 2D intensity distribution of the incident beam at the GEM monitor was also measured using an Imagine Plate (IP) (Fuji Photo Film Co., Ltd) for comparison.

Figure 3 shows the comparison of the lateral bean intensity distributions between the GEM detector and IP. The beam intensity distribution measured with the GEM detector is in good agreement with those of IP. The experimental result has demonstrated that the GEM-based detector can measure the beam position and the lateral beam-profile simultaneously. Therefore, if we replace the conventional multiple-detectors for monitoring beam parameters with a single GEM-based transmission monitor, it is possible to reduce the multiple scattering and struggling effects caused by the multiple-detectors.

References

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2) Terakawa A., et al., *Proc. of the 16th Pacific Basin Nuclear Conference (16PBNC), Oct. 13-18, 2008, Aomori, Japan*, PapaerID P16P1378, 1.

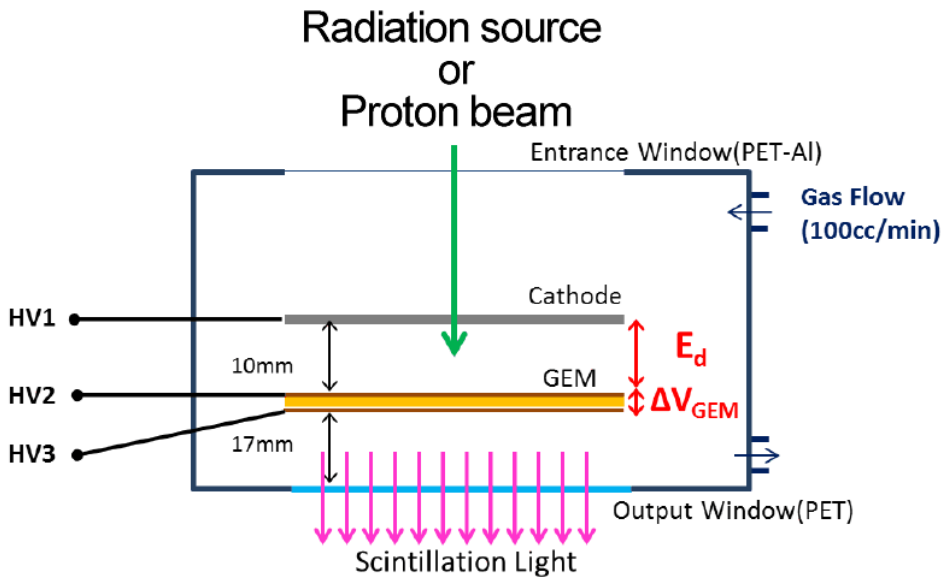

Figure 1. Micro-pattern gaseous detector based on gas electron multiplier technology developed as a prototype transmission beam monitor for charged particle therapy. ^{55}Fe and ^{241}Am were used as radiation sources to measure the gas gain (The ^{241}Am source was placed between the cathode and GEM.).

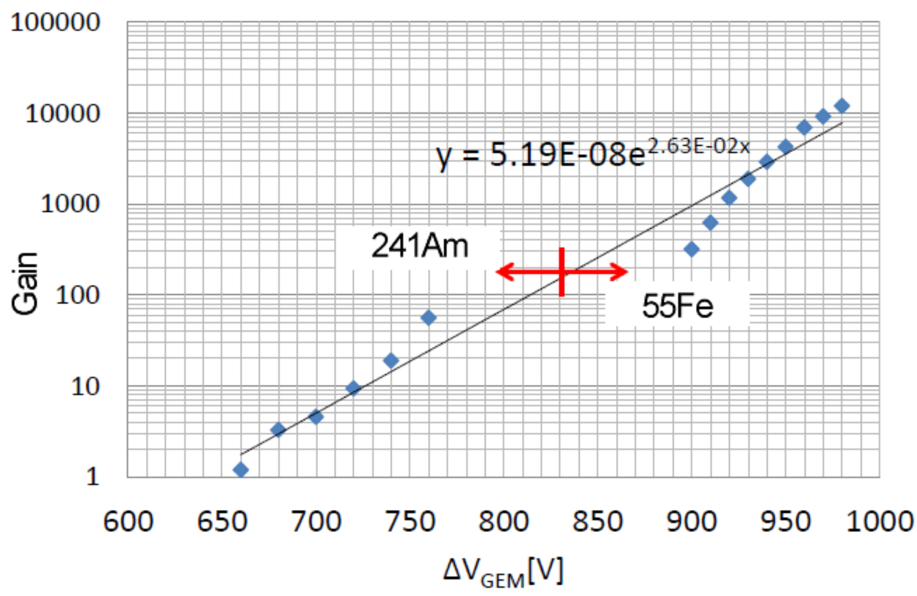

Figure 2. Gas gain of the single glass-GEM as a function of ΔV_{GEM} evaluated with ^{55}Fe (5.9 keV-X-ray) and ^{241}Am alpha sources.

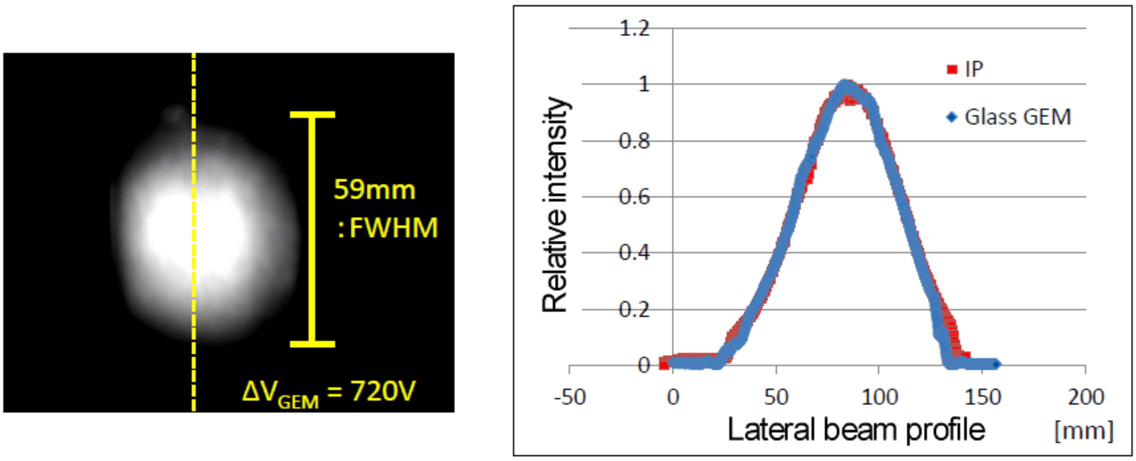

Figure 3. Scintillation due to proton beam irradiation from the glass-GEM and comparison of the lateral beam profile between the GEM monitor and IP.