Performance of the GEM detector based on Korean foils for the CMS muon upgrade

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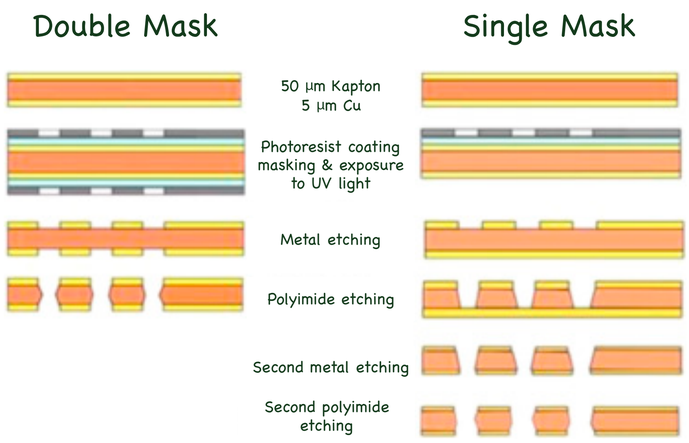
Introduction

GEM detectors have been developed for the Phase II upgrade and will be installed at the endcap stations of the CMS muon system. In detail, GE1/1 will be installed during LS2 and GE2/1 & ME0 later. This upgrade will improve the muon trigger and tracking performance in high-η region.

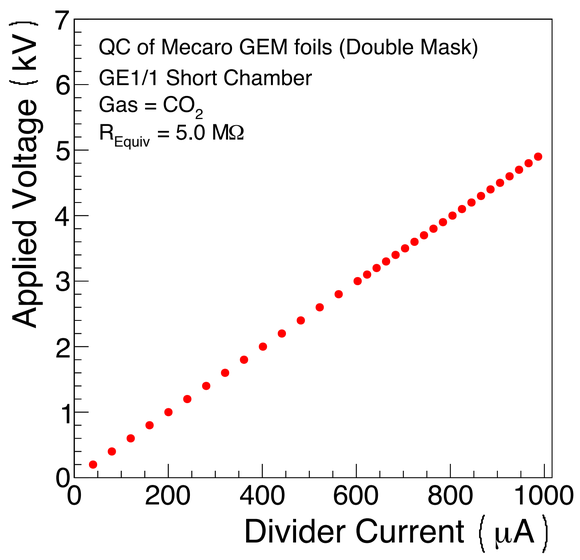
Korea CMS (KCMS) group and Mecaro, a company in Korea, have been jointly developing large GEM foils using the double-mask technique while CERN using the single-mask technique. Compared to the single-mask technique, the double-mask technique has simpler production process and more symmetric shape of GEM holes. Therefore, foils produced by Mecaro will play an important role in upgrade of the CMS muon system, especially for GE2/1 & ME0.

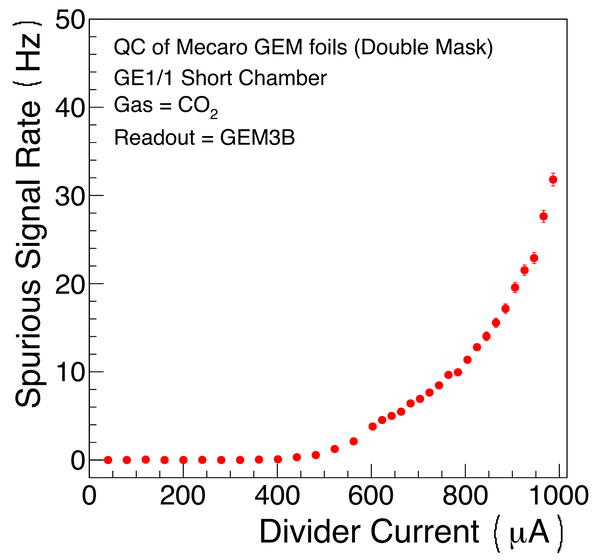
We have built the first GEM chamber with large double-mask foils produce by Mecaro. We present the results of several quality control (QC) tests on this GEM chamber.



Quality Control with Mecaro GEM foils

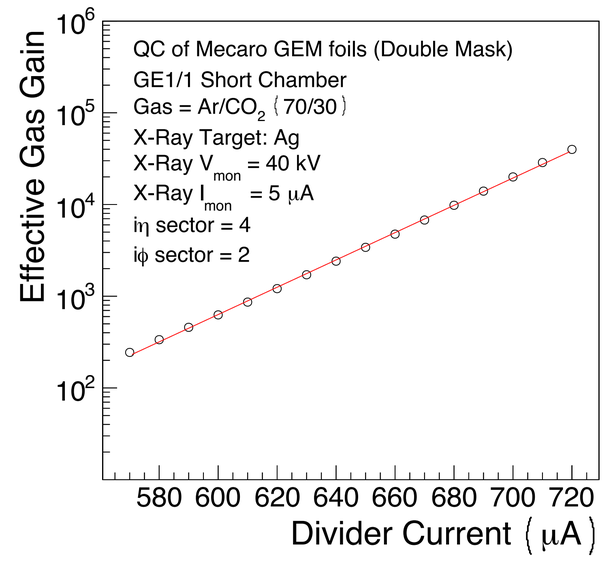
High Voltage test

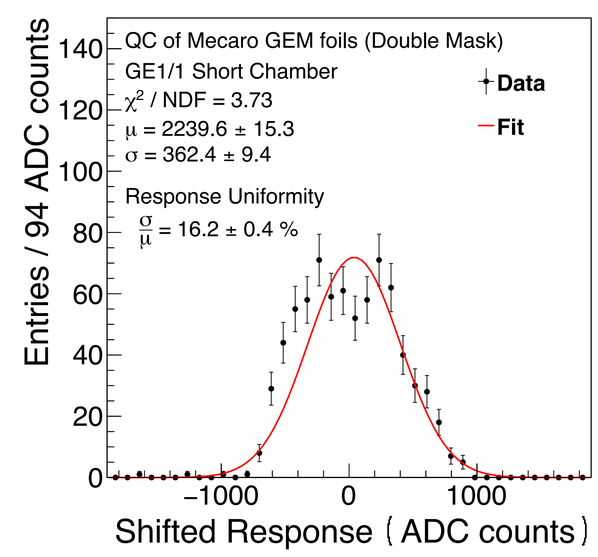




- V vs. I curve
  - Good linear shape without any discharge up to 5 kV
- Spurious signal rates
  - Spurious signals due to leakage current between internal frames and GEM
  - Pulse output from the bottom electrode of the 3rd GEM foil
  - Rate < 10 Hz at the nominal operating point (700 μA)
  - QC requirement is satisfied

Gain & Uniformity





- Effective gas gain
  - Gain is around 20000 at the nominal operating point
  - Comparable to the result of CERN foils
- Response uniformity
  - The response is measured in ADC peak positions of each slice which is a bundle of 4 strips
  - Consistent with the results from CERN foils
  - Slightly above the TDR requirement (15%)

Further studies in progress

- Rate capability
  - To study the characteristics of GEM foils
  - Check the stability of effective gain at very high fluxes up to 10^6 Hz/mm²
  - Use the 10cm×10cm GEM chamber
- Discharge studies
  - Due to heavy ionizing trails or intense particle fluxes
  - Possible damage to GEM detectors
  - Estimate the discharge prob. as a function of effective gain
- Aging test @ GIF++
  - Chambers are exposed to gamma ray sources
  - Measurement is ongoing

Summary

- The first GE1/1 chamber with Mecaro double-mask GEM foils was built and tested.
- The QC test results show a similar performance to those of CERN foils.
- We plan to perform additional tests of Mecaro GEM foils using both GE1/1 and 10cm×10cm chambers.

References

[1] F. Sauli, Nuclear Instruments and Methods in Physics Research A 805 (2016) 2-24
[2] A. Colaleo et al., CMS Technical Design Report for the Muon Endcap GEM Upgrade, CERN-LHCC-2015-012, CMS-TDR-013
[3] J. Merlin, Study of long-term sustained operation of gaseous detectors for the high rate environment in CMS, PhD Thesis, CERN-THESIS-2016-041