Digitization update: gain non-uniformity

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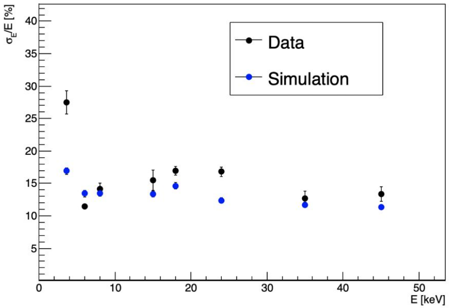
How we currently simulate vignetting

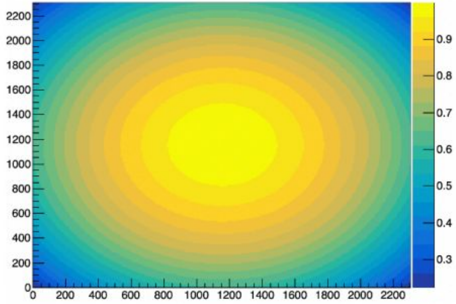
Currently, in digitization, once the track is generated, we apply a map to simulate the vignetting.

Which map? ‘optic’ or ‘cosmic’ map?

The ‘cosmic map’ can reproduce the energy resolution vs energy (Samuele’s studies):

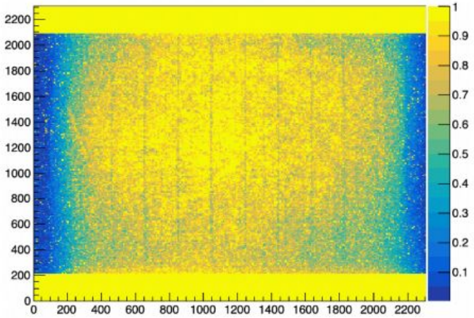


Optical map
(used in reco)



Obtained by illuminating a wall uniformly

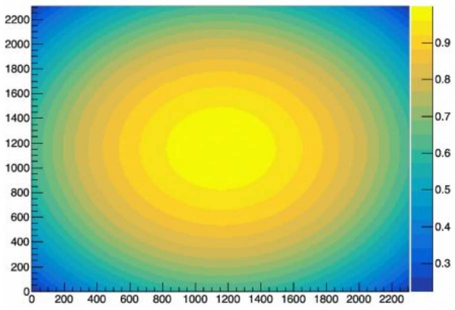
Cosmic map



Obtained with natural radioactivity (contains all non -uniformities)

But, these two method should be equivalent:

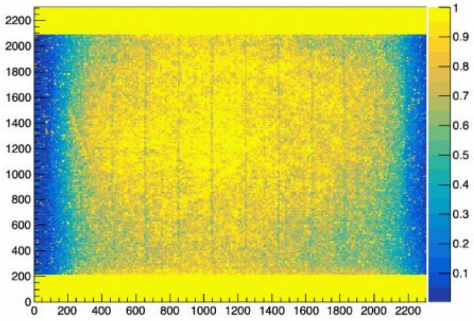
Optical map



Obtained by
illuminating
a wall uniformly

+ gain non-uniformity

Cosmic map



Obtained with natural
radioactivity (contains
all non-uniformities)

We know GEM gain is not uniform in x and y

R. N. Patra, R. N. Singaraju, S. Biswas, Z. Ahammed, T. K. Nayak, Y. P. Viyogi, Measurement of basic characteristics and gain uniformity of a triple gem detector, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 862 (2017) 25–30. doi:10.1016/j.nima.2017.05.011.
URL http://dx.doi.org/10.1016/j.nima.2017.05.011

Abstract

Large area Gas Electron Multiplier (GEM) detectors have been the preferred choice for tracking devices in major nuclear and particle physics experiments. Uniformity over surface of the detector in terms of gain, energy resolution and efficiency is crucial for the optimum performance of these detectors. In the present work, detailed performance study of a $10\times10\,cm^2$ triple GEM detector operated using Ar and CO_2 gas mixtures in proportions of 70:30 and 90:10, has been made by making a voltage scan of the efficiency with ^{106}Ru-Rh β-source and cosmic rays. The gain and energy resolution of the detector were studied using the X-ray spectrum of ^{55}Fe source. The uniformity of the detector has been investigated by dividing the detector in 7×7 zones and measuring the gain and energy resolution at the centre of each zone. The variations of the gain and energy resolution have been found to be 8.8% and 6.7%, respectively. These studies are essential to characterise GEM detectors before their final use in the experiments.

-> For a 3-GEM-stack of 10x10 cm^2, the gain variation was found to be ~ 8.8% in 1.5x1.5 cm^2 squares

How to simulate this effect only:

We could take into account for this effect, by applying a gain fluctuation in x and y.

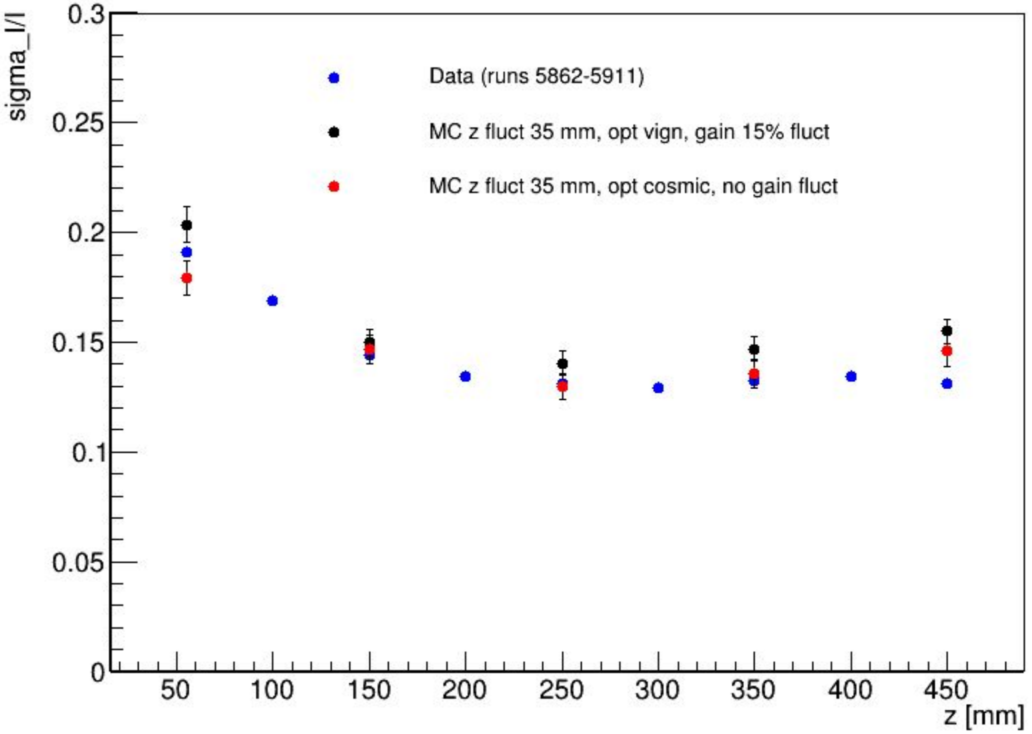
If the tracks ar not too long (Fe55), it makes sense to apply the fluctuation **on the whole track** (since the track is fully contained in a 1.5x1.5 cm^2 square).

The variation in gain in our case could be **higher then 8.8%** since our GEMs are 10 times larger.

(for simplicity, I applied the fluctuation on the gain of the first GEM only)

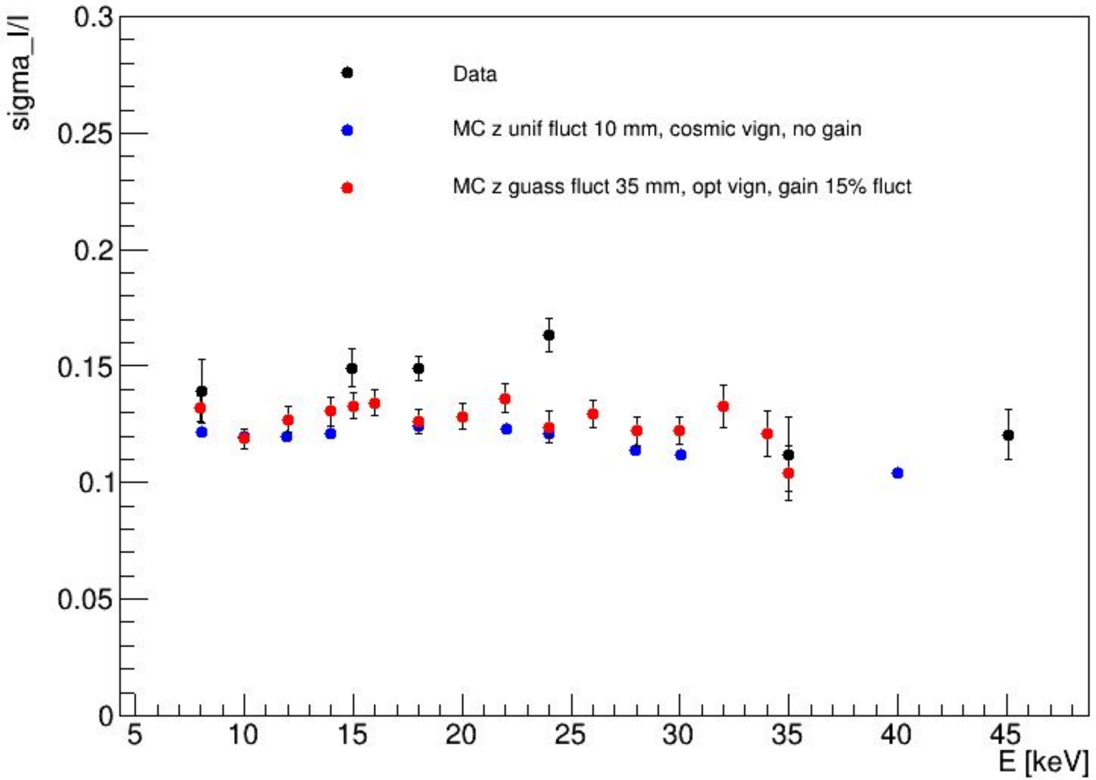
Resolution vs Z (LIME overground Fe55 data vs MC)

A 15% gaussian fluctuation on the first GEM (event per event) can reproduce data



Resolution vs Energy (LIME overground data vs MC)

A 15% gaussian fluctuation on the first GEM (event per event) can reproduce data



Conclusions

- The right way to apply the gain non-uniformity might be different: now just on the first GEM
- For longer tracks it’s easier to apply the map
- Since the two methods seem to be equivalent, we could choose the simple method: ‘cosmic map’ (but at LNGS we don’t have it…, maybe with iron non collimated?)