Saturation measurement with ^{55}Fe and muons in GIN detector

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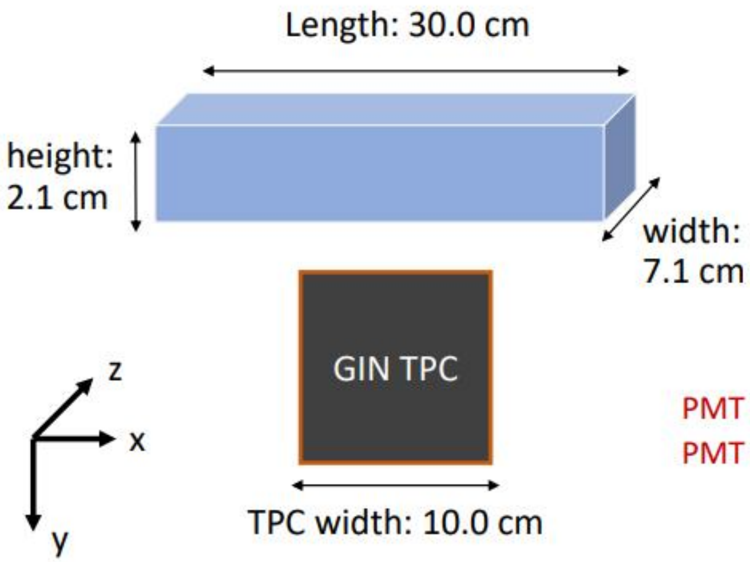
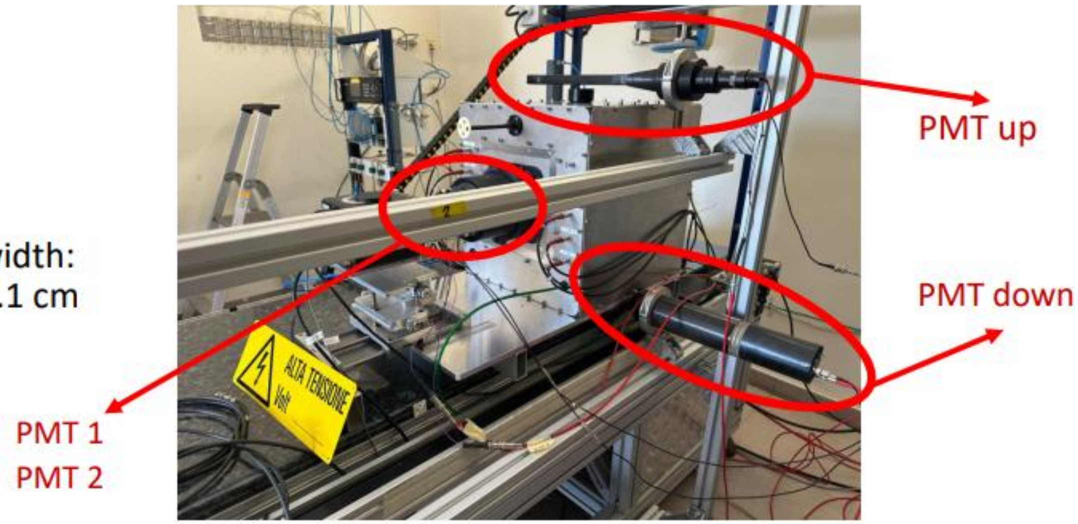
Aim

We want to measure the saturation effect produced by the 3rd oxided GEM for an iron source emitting 5.9 keV photons, using muon signals as a reference for non-saturating tracks.

Set up: GIN detector

Two scintillator crystals above and below along with two PMTs (up, down) and two PMTs near the camera (1, 2).





- Trigger on coincidences between the PMT up and down or between PMT 1 and 2.
- Scintillators can be moved along the drift direction (z) to allow selection of vertical muons within a z range.

Steps

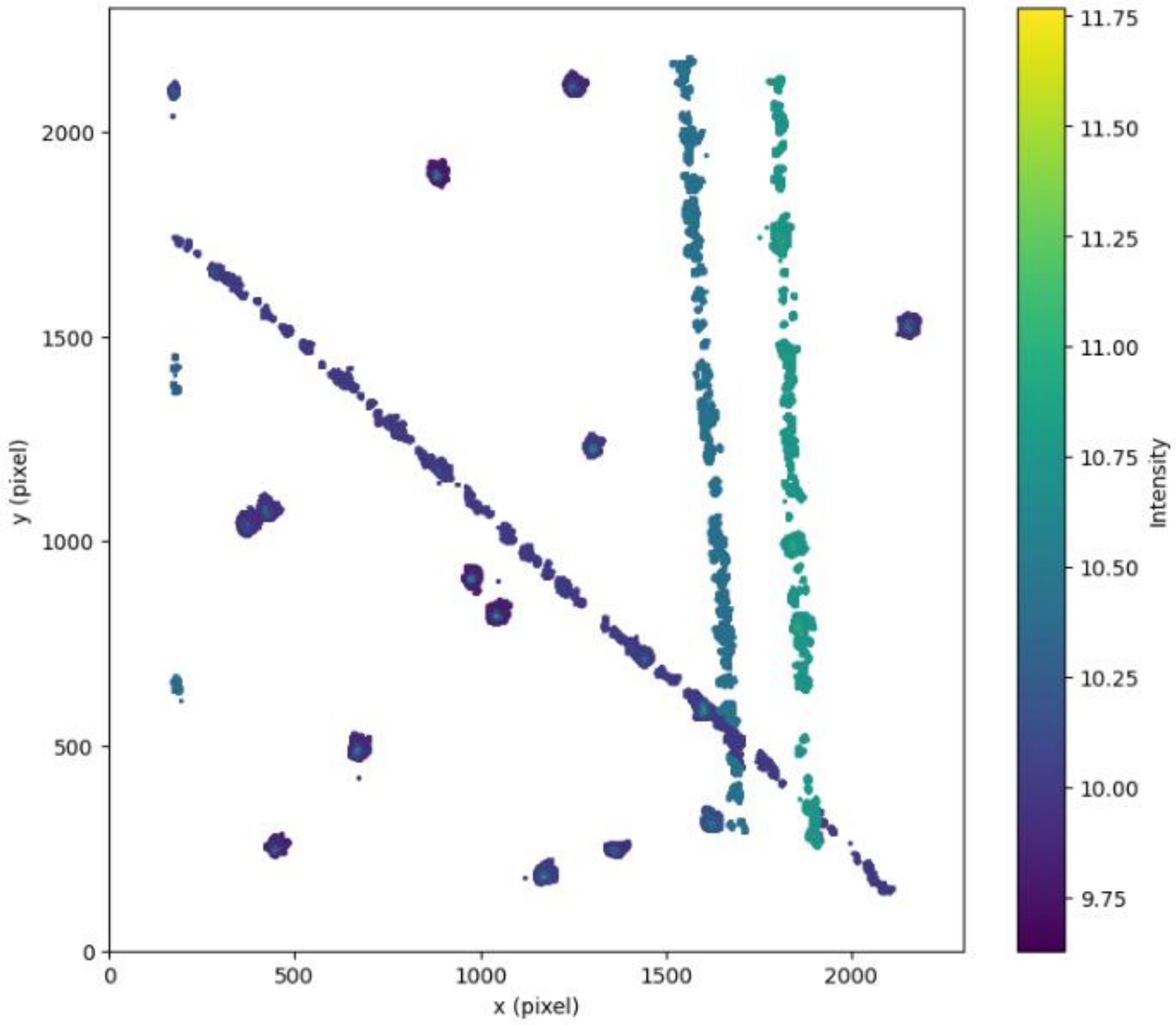
1. Estimate the attenuation energy curve using muon signals at different distances from the GEMs. Muons are expected to suffer only attenuation because they are MIP.
2. Rescale the curve produced by the iron source signal at different positions by removing the attenuation contribution calculated from muons. Verify the behavior of the iron signal to investigate the potential contribution of saturation in iron.

1. Muon data taking

- The detector operated with E_{drift}=1 kV/cm, V_{GEM}=440 V and camera exposure time of 80 ms.
- Muons were collected for 11 different positions. For each position, 4-5 runs were taken, each containing 500 muon events triggered by PMTs up and down.

Positions z of the scintillator centre from the first GEM [cm] ± 0.2 cm (positioning error)										
3.2	4.5	5.7	6.9	9.0	11.0	12.5	14.9	16.5	18.7	21.5

1. Example of an image



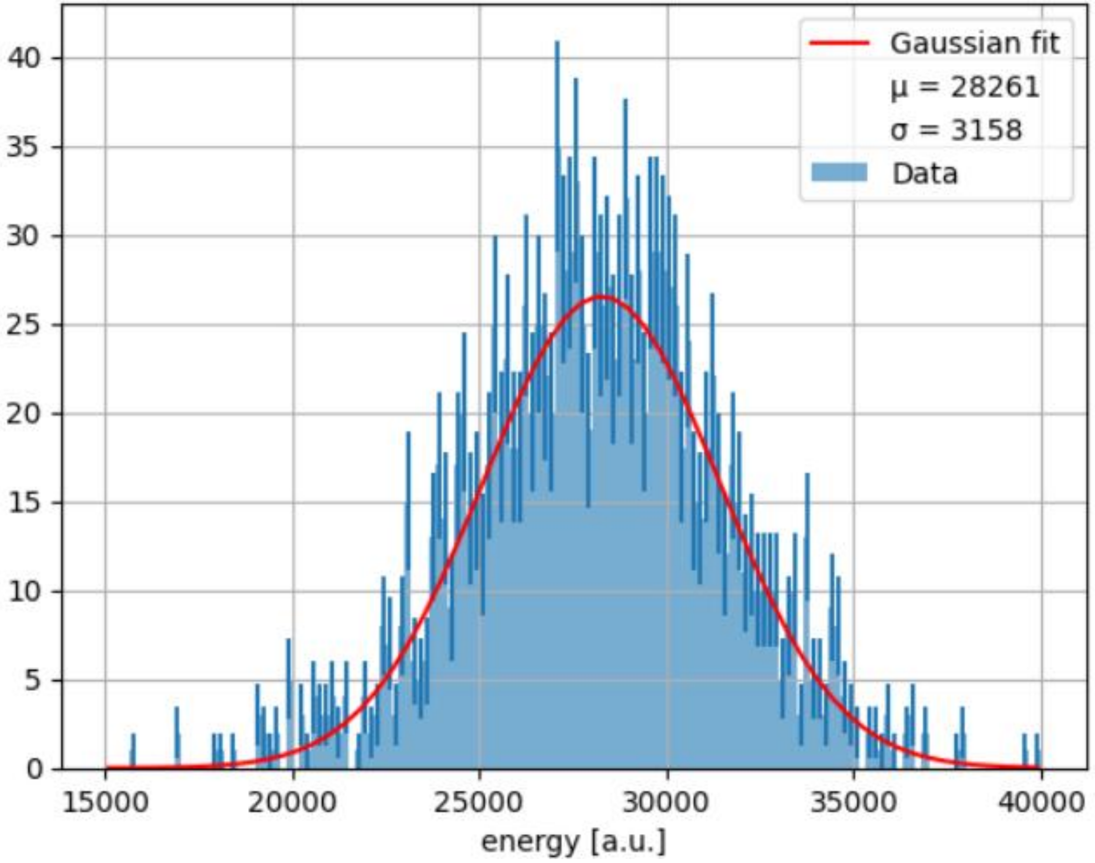
- The recorded energy depends on external conditions (such as humidity, pressure, temperature)
- Runs last 6 hours

The iron source was adoperated as calibration point, as it produces a signal of fixed energy (5.9 keV). It was placed the middle of drift direction (z=12.1 cm)

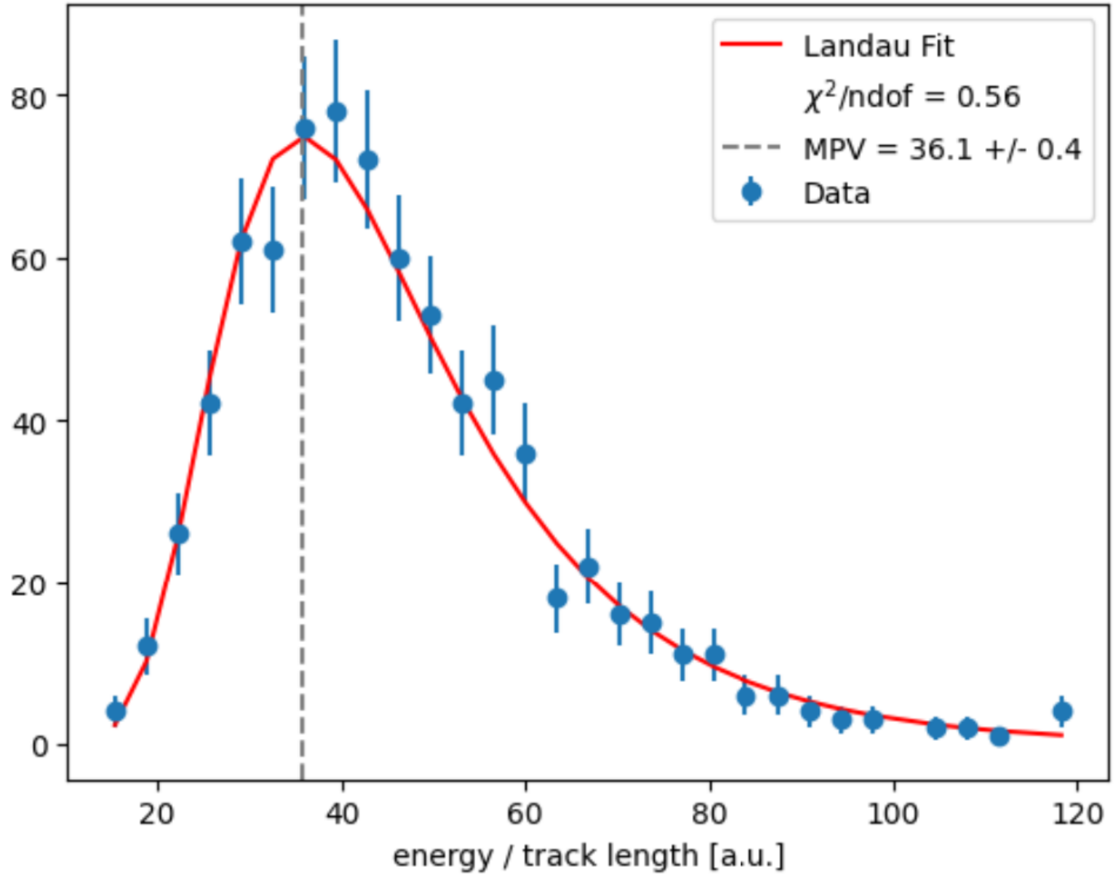
By comparing the gaussian peaks of iron in different runs, an “energy rescaling” was performed, using the peak of the first run as the reference.

1. Muon analysis

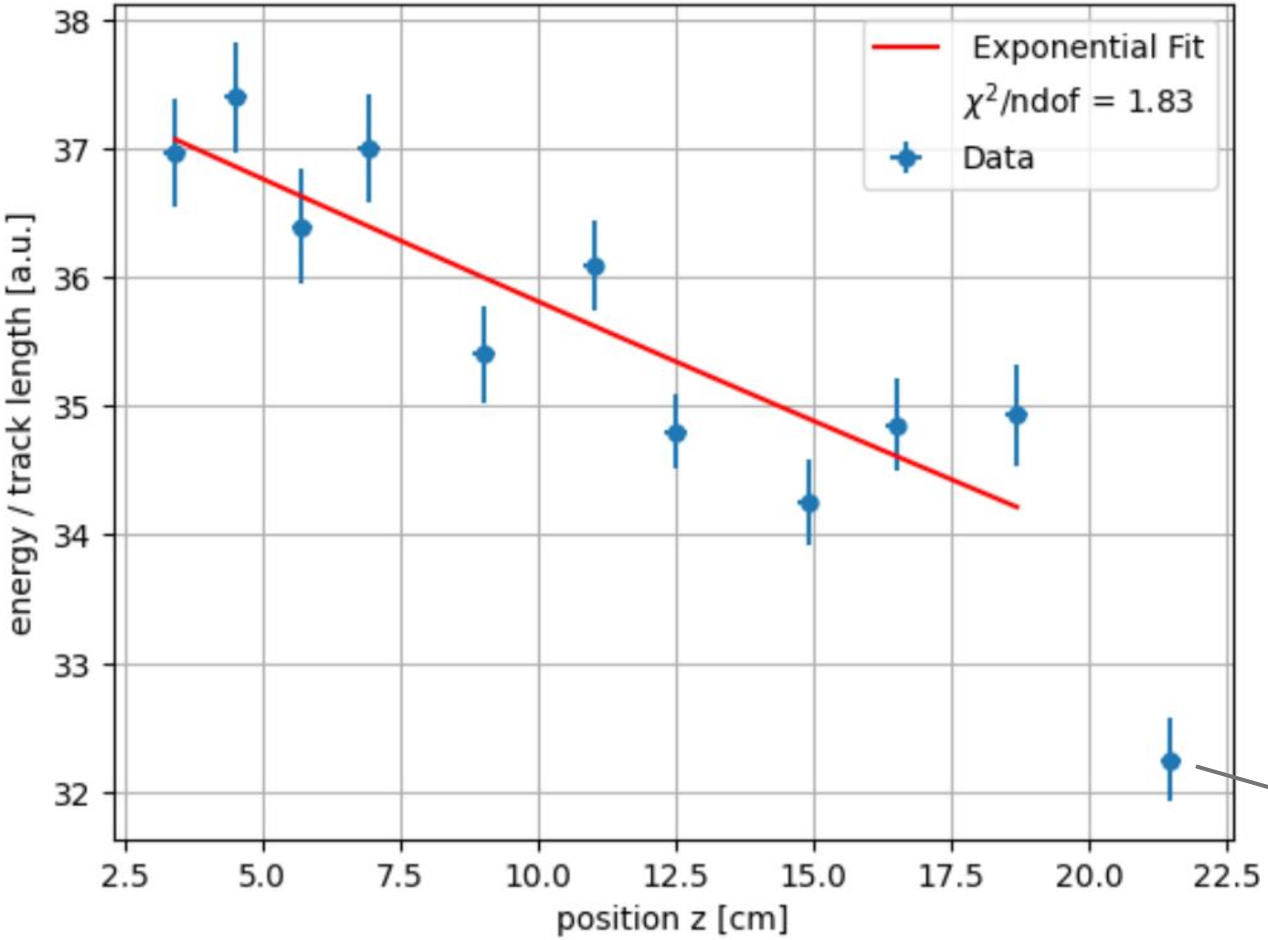
- Example of an <u>iron energy peak</u> in a muon run:



- Example of <u>landau distribution of the muon energy divided by its track length</u> for a specific position z. The MPV value is extracted with truncated mean method.



1. Attenuation curve for muons



excluded from the fit

Exponential fit function:

$$y = Ae^{-\alpha z}$$

A	α
(37.7 ± 0.5)	(0.0052 ± 0.0010) cm^{-1}

Attenuation coefficient:

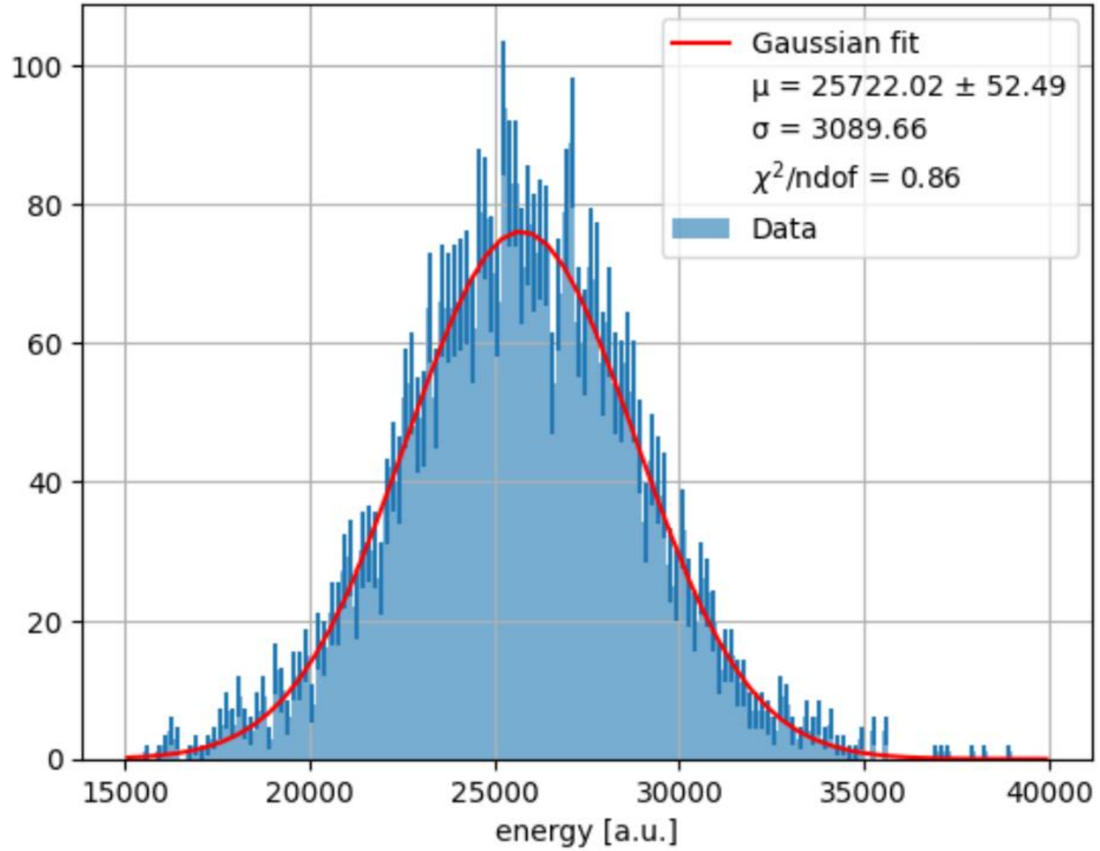
$$\lambda = \frac{1}{\alpha} = (190 \pm 40)\ \text{cm}$$

2. Iron data taking and analysis

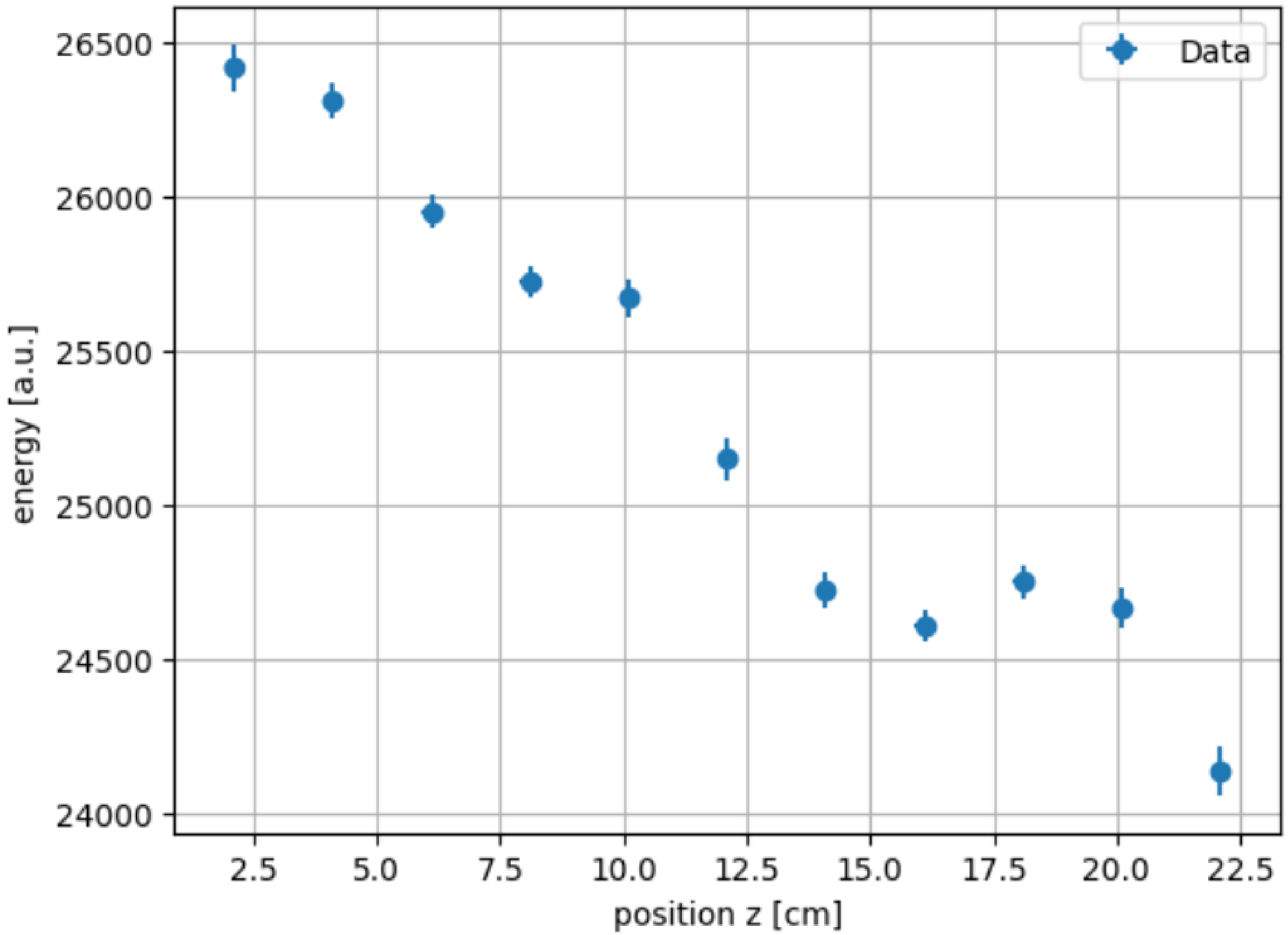
- Iron signal was collected for 11 different positions. For each position, 1 run was taken, containing 700 events triggered by the PMT 1 and 2.

Positions z from the first GEM [cm] ± 0.1 cm (positioning error)										
2.1	4.1	6.1	8.1	10.1	12.1	14.1	16.1	18.1	20.1	22.1

- For each position, the iron peak was extracted:

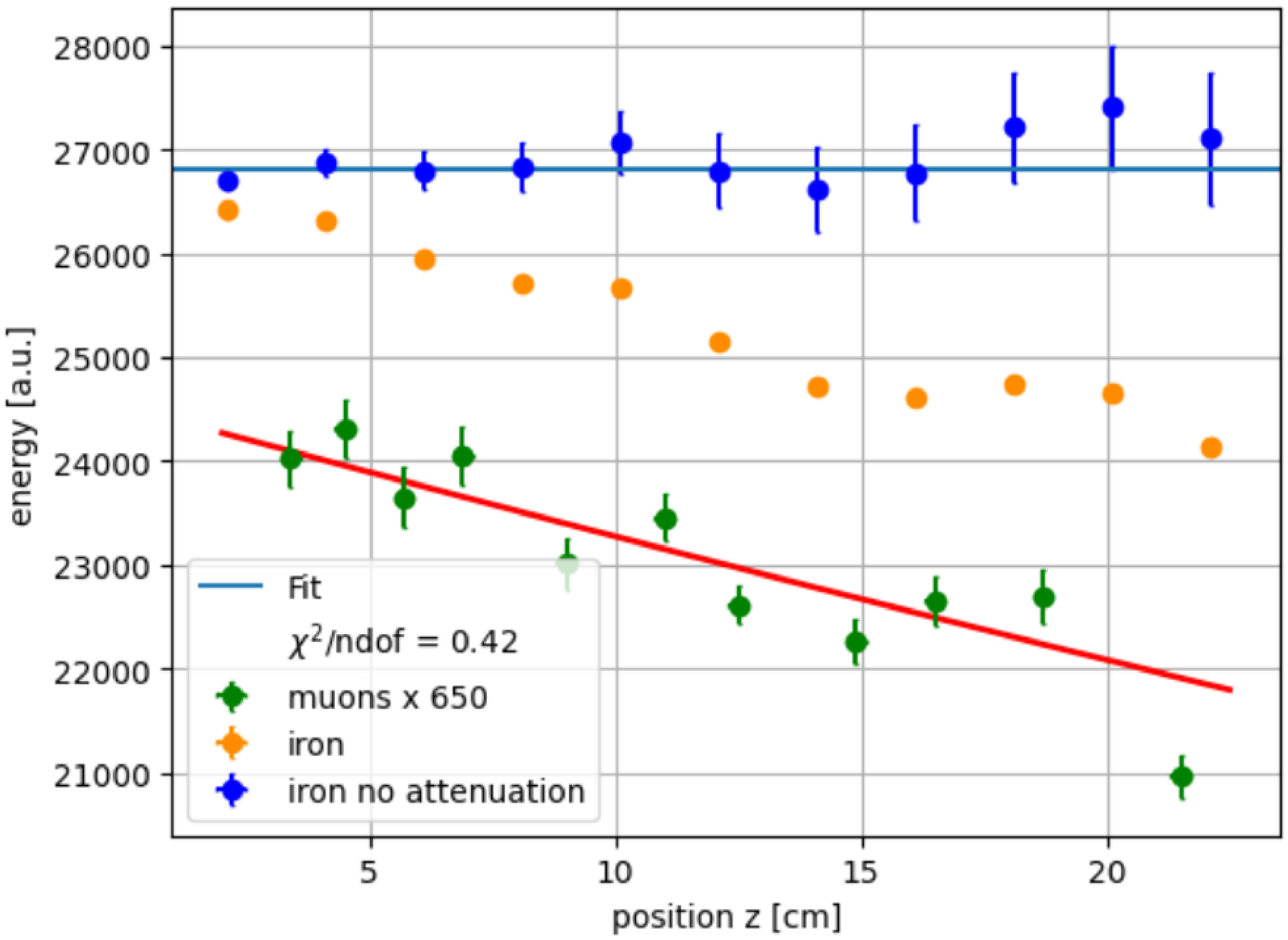


2. Iron curve



Data
26500
26000
25500
25000
24500
24000
energy [a.u.]
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
position z [cm]

2. Removal of attenuation from iron signals



- The <u>corrected iron curve results constant</u>, as expected for the signal of a source of fixed energy.
- Between the highest and the lowest point, the <u>relative difference is ~ 1%</u>.
- We can conclude that **there is not saturation with the 3rd oxided GEM, working at 440 V (~ 420 V at LNGS), E_{drift}=1 kV/cm for a signal of 5.9 keV**.

NEXT STEPS: Looking for the presence of saturation at 450 V and 460 V.

Thank you!