CYGNO simulations update

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for the simulation group

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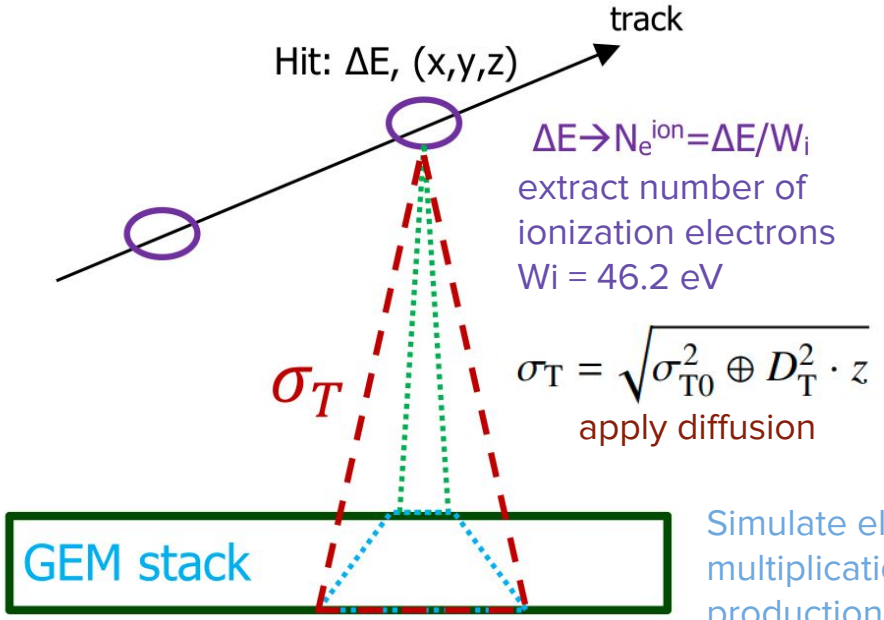
CYGNO general meeting

MC validation with LIME ^{55}Fe data

Simulation of images

Spatial distribution of energy depositions ΔE,(x,y,z) from MC truth GEANT4 (SRIM) for ER (NR)



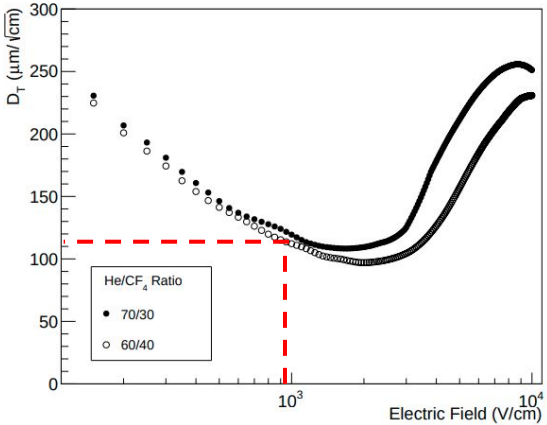
$\Delta E \rightarrow N_e^{ion} = \Delta E / W_i$

extract number of ionization electrons

Wi = 46.2 eV

$$\sigma_T = \sqrt{\sigma_{T0}^2 \oplus D_T^2 \cdot z}$$

apply diffusion



$$D_T^{60/40} = 115 \ \frac{\mu m}{\sqrt{cm}}$$

$$\sigma_{T0}^{60/40} = (280 \pm 60) \ \mu m$$

For 930V/cm drift field

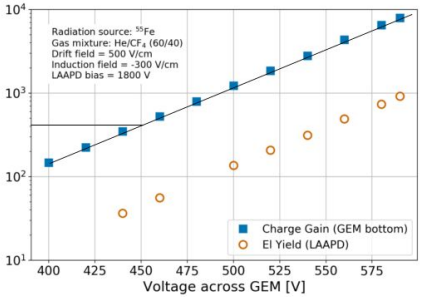
Simulate electron multiplication & light production in GEM stack

F. Petrucci

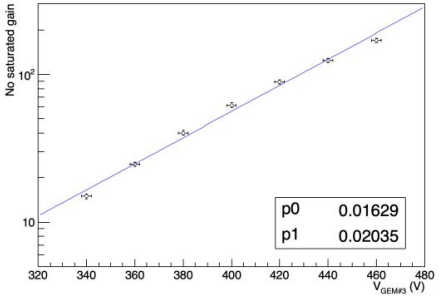
Simulation of GEM gain + light production

- Single GEM gain for HV @450V: 400 (portugues group measurement)
- Extraction x Collection efficiency of electrons in GEM1 and GEM2: 0.33

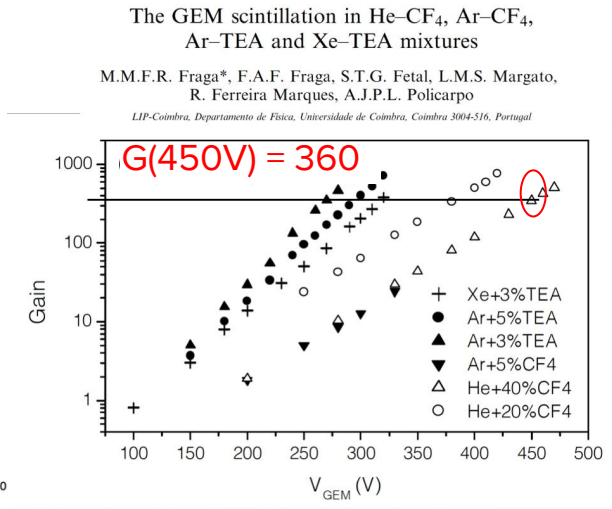
$$G(450V) = 400$$



Single GEM gain as measured by Fernando



Single GEM gain by Fraga et al.



Single GEM gain as measured by F&K

$$\frac{I_3}{I_2}(450V) = G(450V) \times \epsilon_{extr}^{GEM\#2} \times \epsilon_{coll}^{GEM\#3} = 132$$

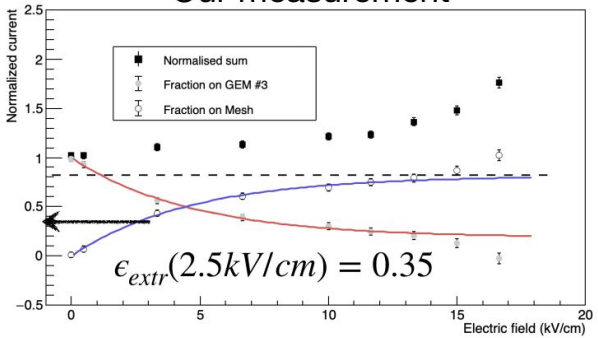
$$\epsilon_{extr}^{GEM\#2} \times \epsilon_{coll}^{GEM\#3} = 0.33$$

D. Pinci

Simulation of GEM gain + light production

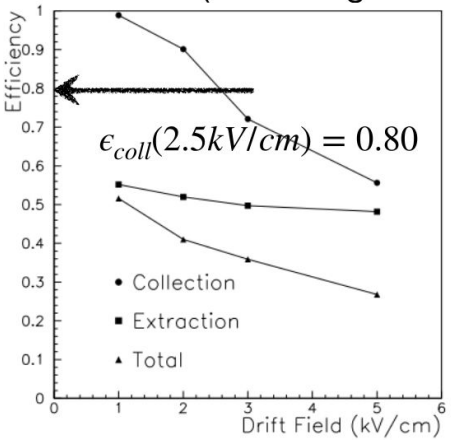
- Single GEM gain for HV @450V: 400 (portugues group measurement)
- Extraction x Collection efficiency of electrons in GEM1 and GEM2: 0.33

Our measurement



$\epsilon_{extr} \times \epsilon_{coll} = 0.33$ Reasonable

Simulation (different gas mix)



Therefore:

$G_1 = G_2 = 130$;

$G_3 = g = 400$;

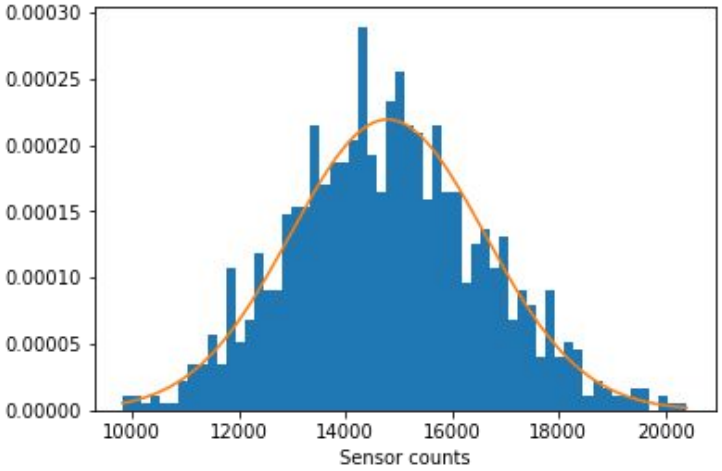
Simulation of GEM gain + light production

- Single GEM gain for HV @450V: 400 (portugues group measurement)
- Extraction x Collection efficiency of electrons in GEM1 and GEM2: 0.33
- Light yield: 0.07 photons/electrons
- ORCA Fusion:
  - 2304 x 2304 pixels (1 pixel 6.5 um x 6.5 um)
  - Camera aperture 0.95
  - Sensor size 14.976 mm
  - Sensor calibration → 1 photon = 2 sensor counts
- Active area: 35 cm x 35 cm
- Distance from the GEM: 30 cm
- Geometry factor of light collection: $\Omega=1/(4(d+1)*a)^2$
  - d = ratio between image size (350 mm) and sensor size (14.976 mm)
  - a = camera aperture (0.95)

Light for ^{55}Fe spot

Prediction from toy MC

- GEM voltage: 450V



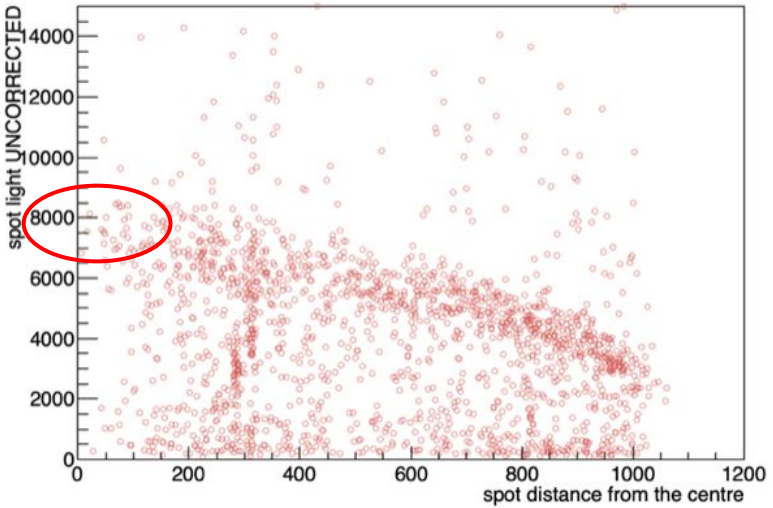
mean = 14783 counts

sigma = 1811

resolution = 0.122

Run 3645 in LIME: GEM @450V, z = 30 cm

- no vignetting correction
- no saturation correction
- select round spots



In the center (vignetting correction =1) ~8000 counts

➜ about **1.8 factor** less than MC

➜ from saturation simulations by Davide we expect **1.7**

Residual data-MC difference explained by saturation

Conclusions & next steps

- Simulation of ^{55}Fe spot predicts the correct amount of light
  ➜ consistent with that observed in data, taking into account vignetting and saturation
- Need to test the consistency for different GEM voltages and different source z
  ➜ we have z-scan data taken in LIME last summer
- Check energy resolution in data and MC
  ➜ from preliminary analysis ~12% energy resolution in MC and 17% in data
- Data-MC comparison and validation also for NR
  ➜ simulation of AmBe in progress
- Study background rejection power vs energy