# CYGNO simulations update

Giulia D'Imperio

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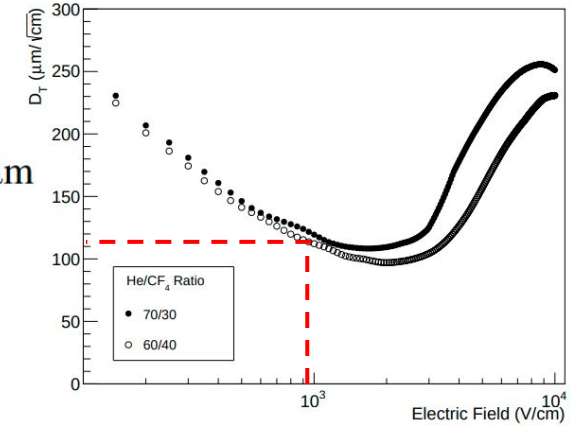
CYGNO simulation meeting

# Toy MC and gain simulation

# Digitization parameters

- Transverse diffusion from https://arxiv.org/abs/2007.00608 for an electric field of 0.93 kV/cm

$$\sigma_T = \sqrt{\sigma_{T0}^2 \oplus D_T^2 \cdot z} \qquad D_T^{60/40} = 115 \ \frac{\mu m}{\sqrt{cm}} \qquad \sigma_{T0}^{60/40} = (280 \pm 60)\ \mu m$$



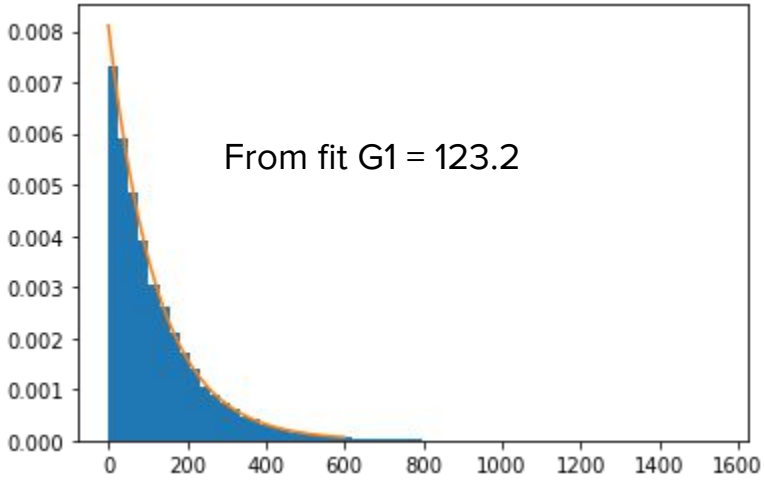

- Active area: 35 cm x 35 cm
- ORCA Fusion:
  - 2304 x 2304 pixels (1 pixel 6.5 um x 6.5 um)
  - Camera aperture 0.95
  - Sensor size 14.976 mm Orca Fusion
- Ionization potential: 46.2 eV (Garfield simulations 42-49 eV)
- Single GEM gain: 123
- light yield: 0.07 photons/electrons
- Sensor calibration ➔ 1 photon = 2 sensor counts
- Distance from the GEM: 30 cm

# Toy MC and gain simulation - 1

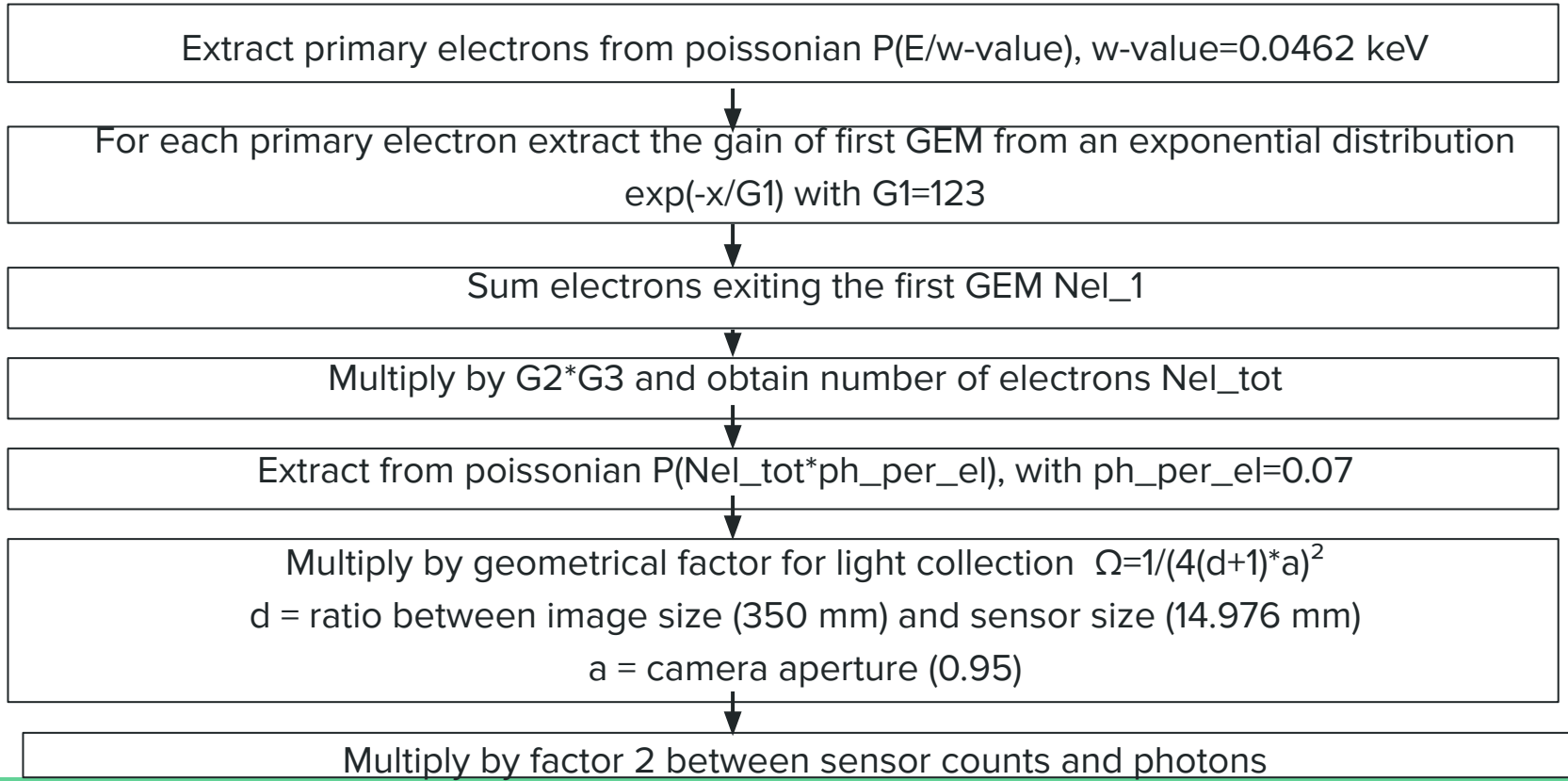
Extract primary electrons from poissonian P(E/w-value), w-value=0.0462 keV

↓

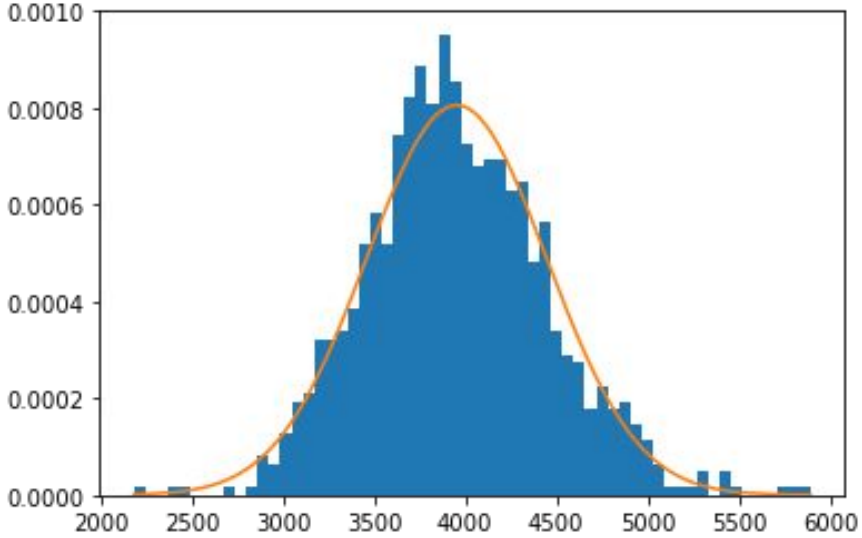
For each primary electron extract the gain of first GEM from an exponential distribution exp(-x/G1) with G1=123



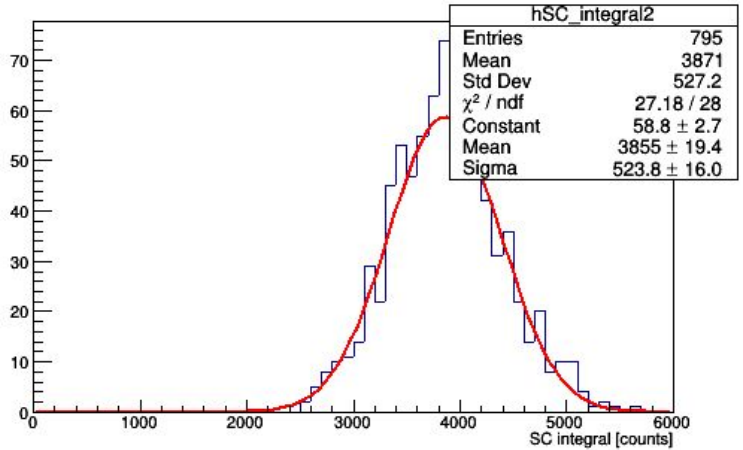
# Toy MC and gain simulation - 2



# Toy MC and gain simulation - 3



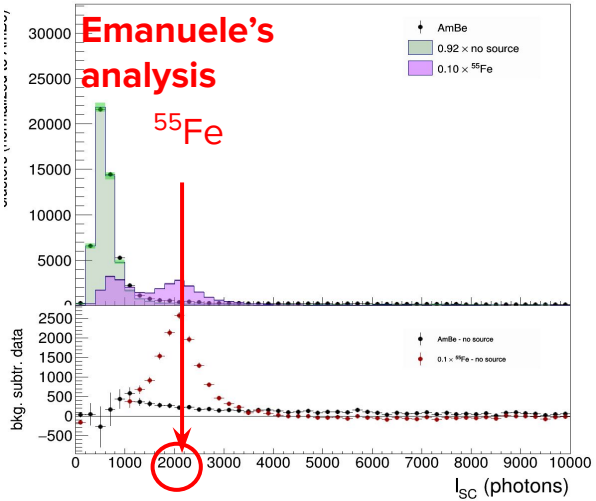

mean = 3951
sigma = 494
resolution = 0.125



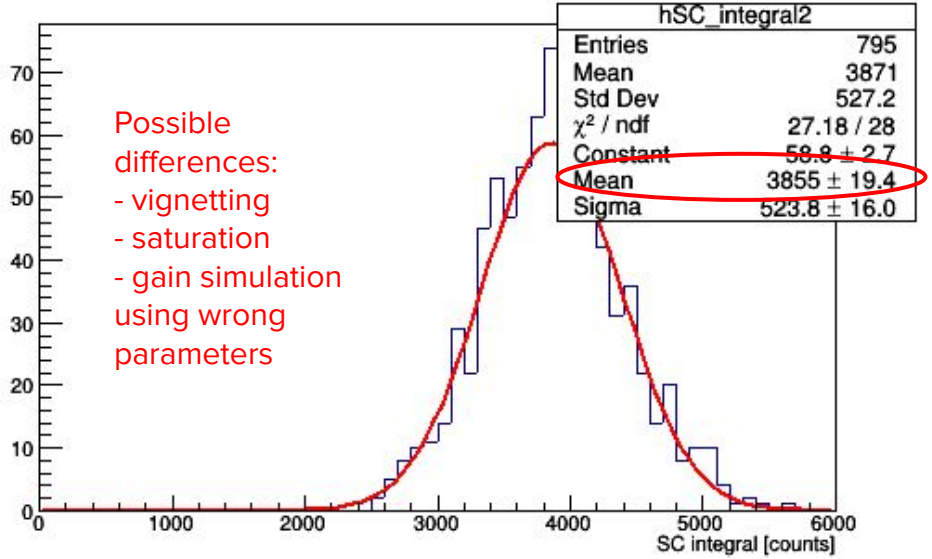

A similar result is obtained after reconstruction
mean = 3855
sigma = 523
resolution = 0.135

# Data-MC comparison $^{55}$Fe

- Average number of counts (sc_integral) for $^{55}$Fe in data in LIME ➔ ~**2000 counts**
- Saturation not corrected
- Vignetting correction applied
- Energy resolution @6 keV ~**17%**



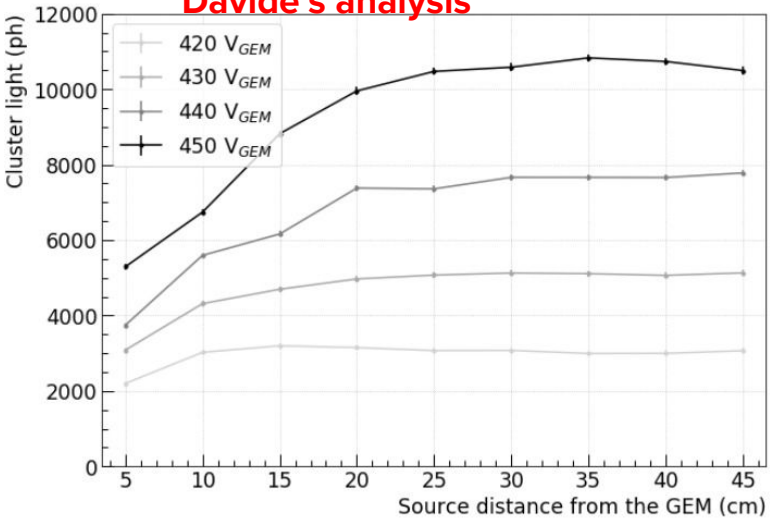

- Average number of counts (sc_integral) for 6 keV ER in MC (LIME conditions) ➔ ~**3900 counts**
- No saturation
- No vignetting
- Energy resolution @6 keV ~**13%**



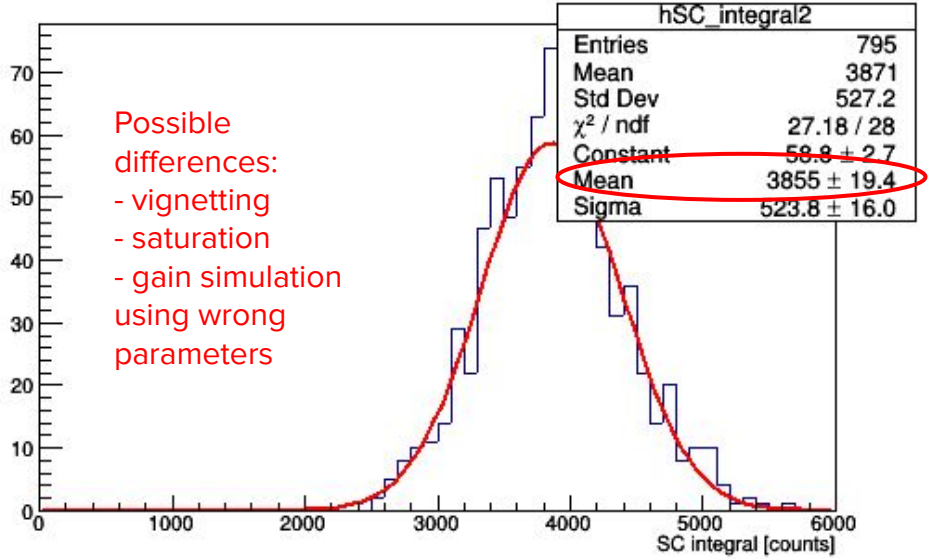
# Data-MC comparison $^{55}$Fe

- Average number of counts (sc_integral) for $^{55}$Fe in data in LIME ➔ ~**11000 counts @450V**
- Saturation not corrected
- Vignetting correction applied

**Davide's analysis**




- Average number of counts (sc_integral) for 6 keV ER in MC (LIME conditions) ➔ ~**3900 counts**
- No saturation
- No vignetting
- Energy resolution @6 keV ~**13%**



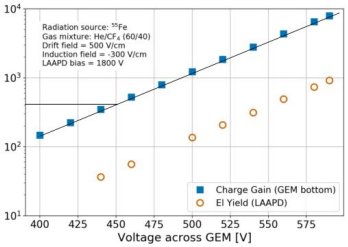

Possible differences:
- vignetting
- saturation
- gain simulation using wrong parameters

# Possible improvements

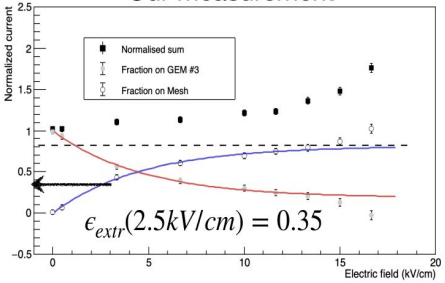
The gain that we are assuming contains already the extraction&collection efficiencies.
For the last GEM we should not include these efficiencies (all electrons are converted to light)

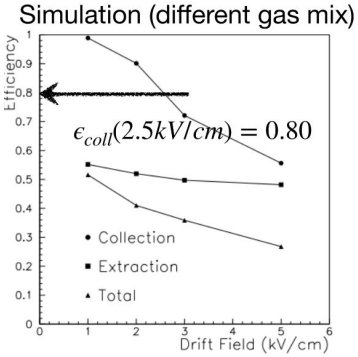
The gain

$G(450V) = 400$




Single GEM gain as measured by Fernando



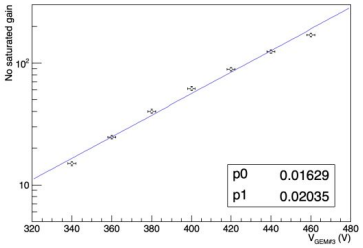




Single GEM gain as measured by F&K

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

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

D. Pinci




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

Therefore:

$G_1 = G_2 = 130;$
$G_3 = g = 400;$

# After fix GEM gain extraction

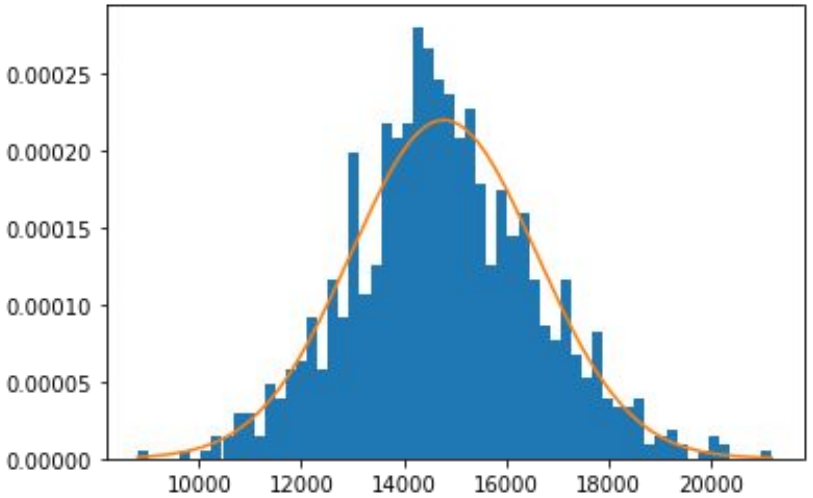
For GEM @450V

$G_1 = G_2 = 130;$

$G_3 = g = 400;$

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

- Need to define what is the correct way to simulate the number of photons
- Energy resolution still slightly better in MC than in data.

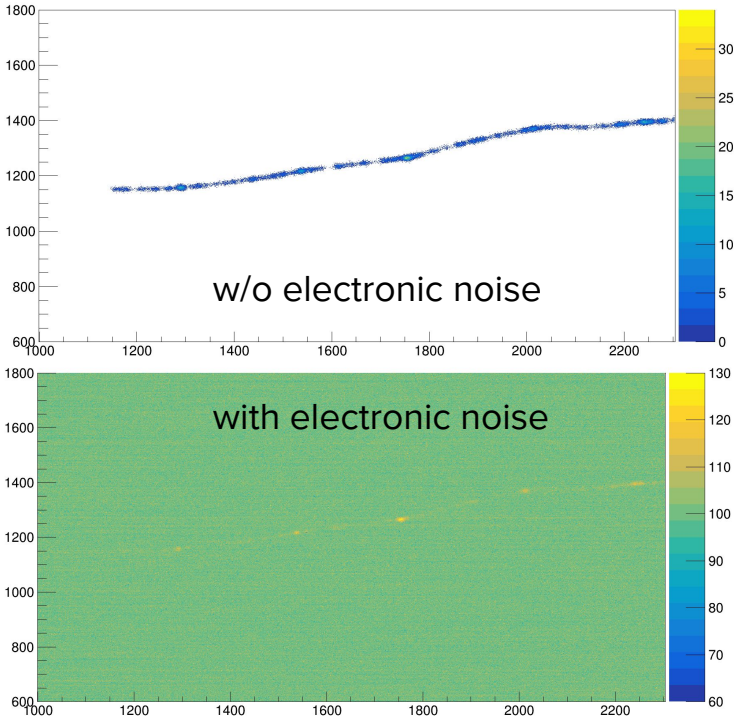


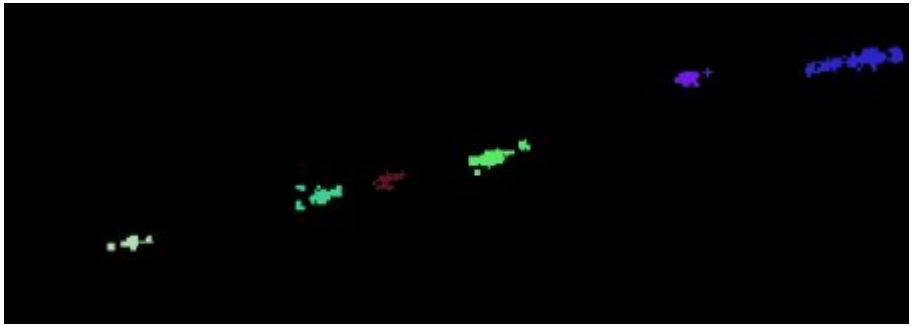

mean = 14783
sigma = 1811
resolution = 0.122

# Test of MC reconstruction

# Reconstruction of ER at higher energy

Example 300 keV track (no noise)



Reconstruction code is not able to identify all parts of the track and recognize that the different spots belong to a single track

Is it compatible with long tracks observed in data?