y d pink floyd p

LET THERE BE MORE LIGHT

Luciano P,
Roberto T,
Alessandro R,
Giovanni M,
Davide P

New Measurements

We started to use LEMON with a mesh 3 mm away from the GEM#3;

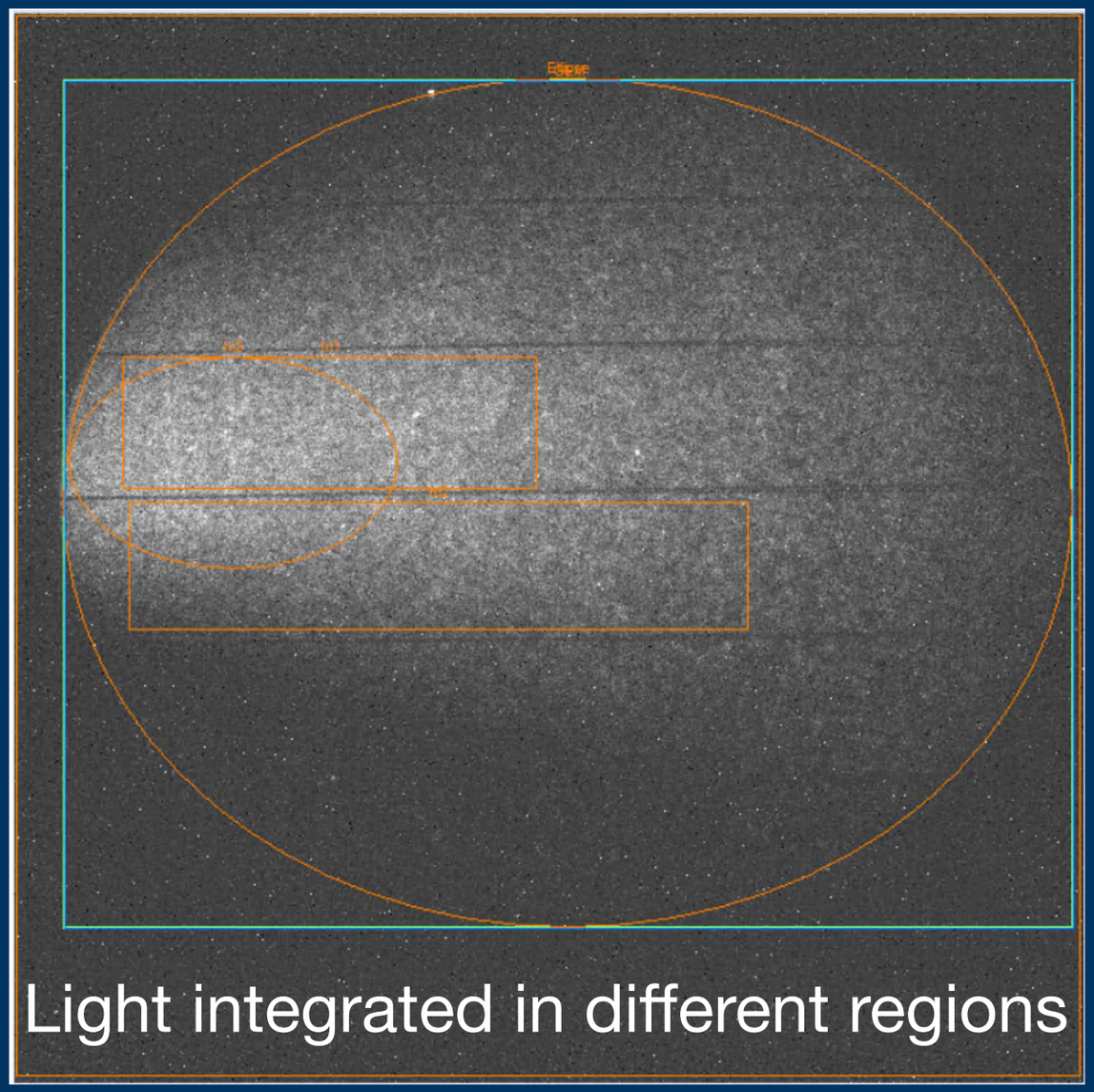
CAEN-HVGEM (A1515TG), allows to acquire the current provided to each channel;

Anode (not used) is grounded as a reference for the HVGEM;

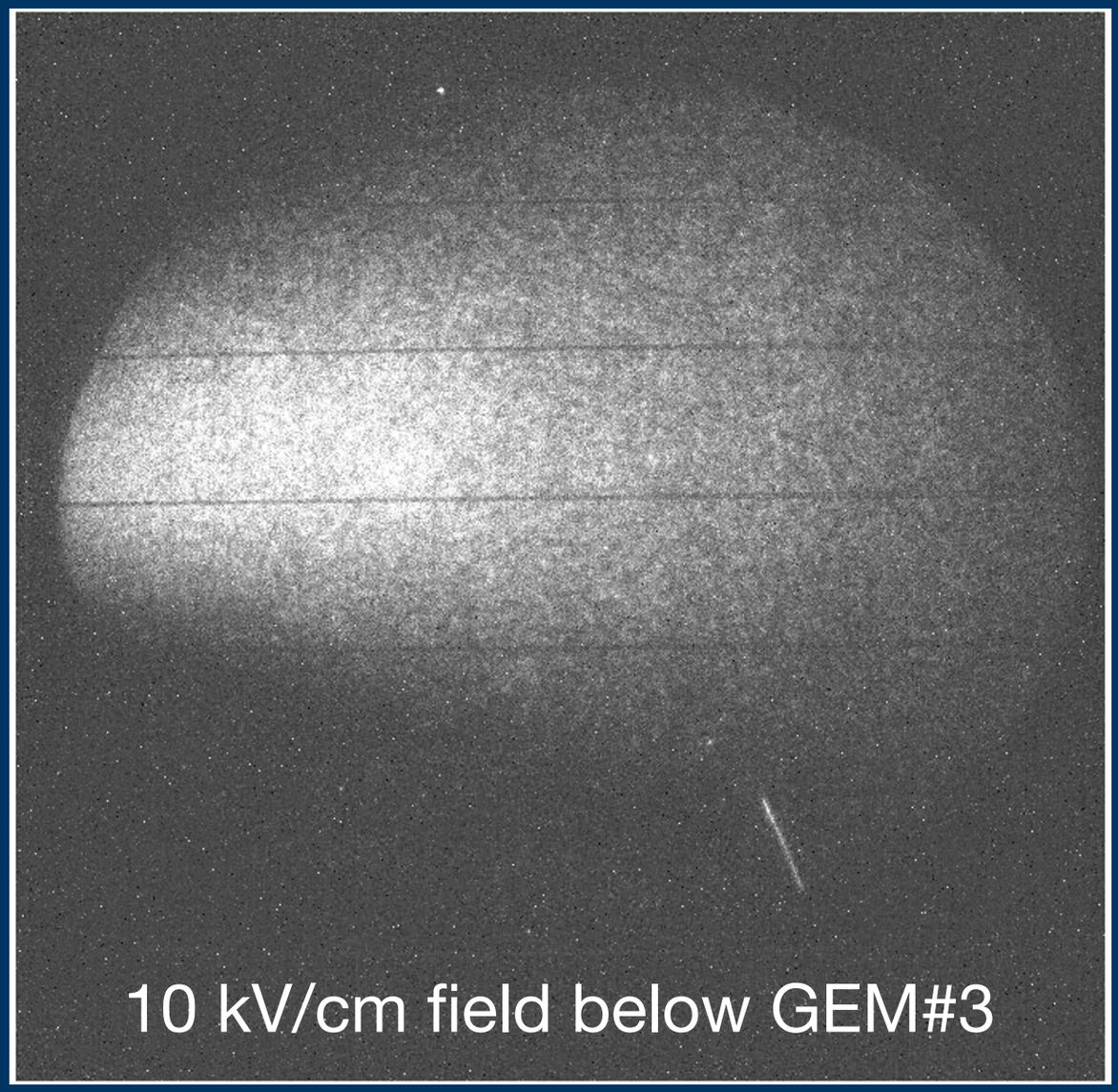
We are using the IMonDet values: leakage currents are automatically subtracted and only signal ones are provided;

The current drawn by the Mesh is acquired by reading the ΔV across a 10 MΩ resistor;

New test at LNF



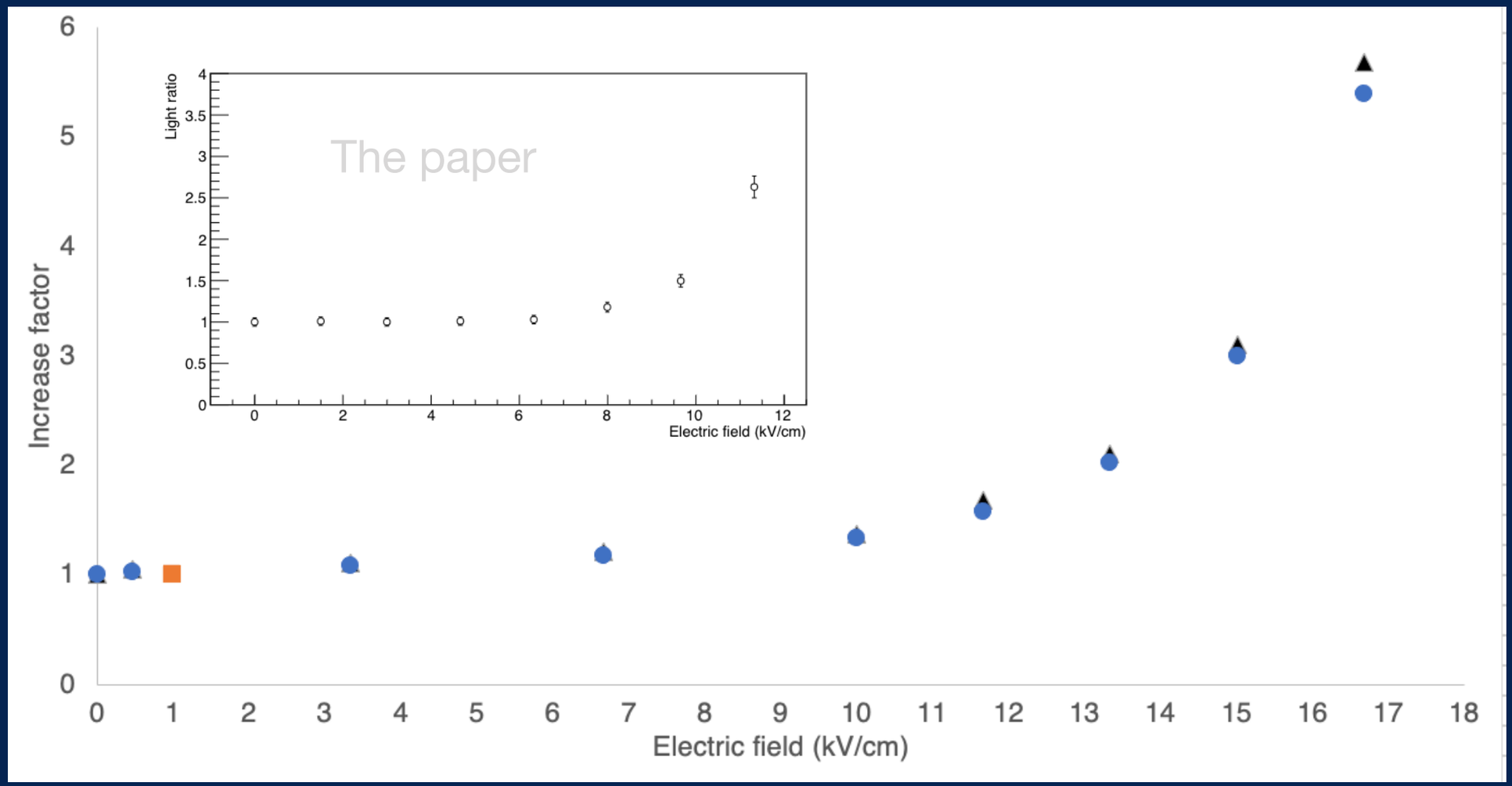
Light integrated in different regions



10 kV/cm field below GEM#3

- The mesh screens more than 55% of light, spoils image reconstruction;
- Mesh issues solved:
  - Fine up to 5kV;
  - Very good flatness;

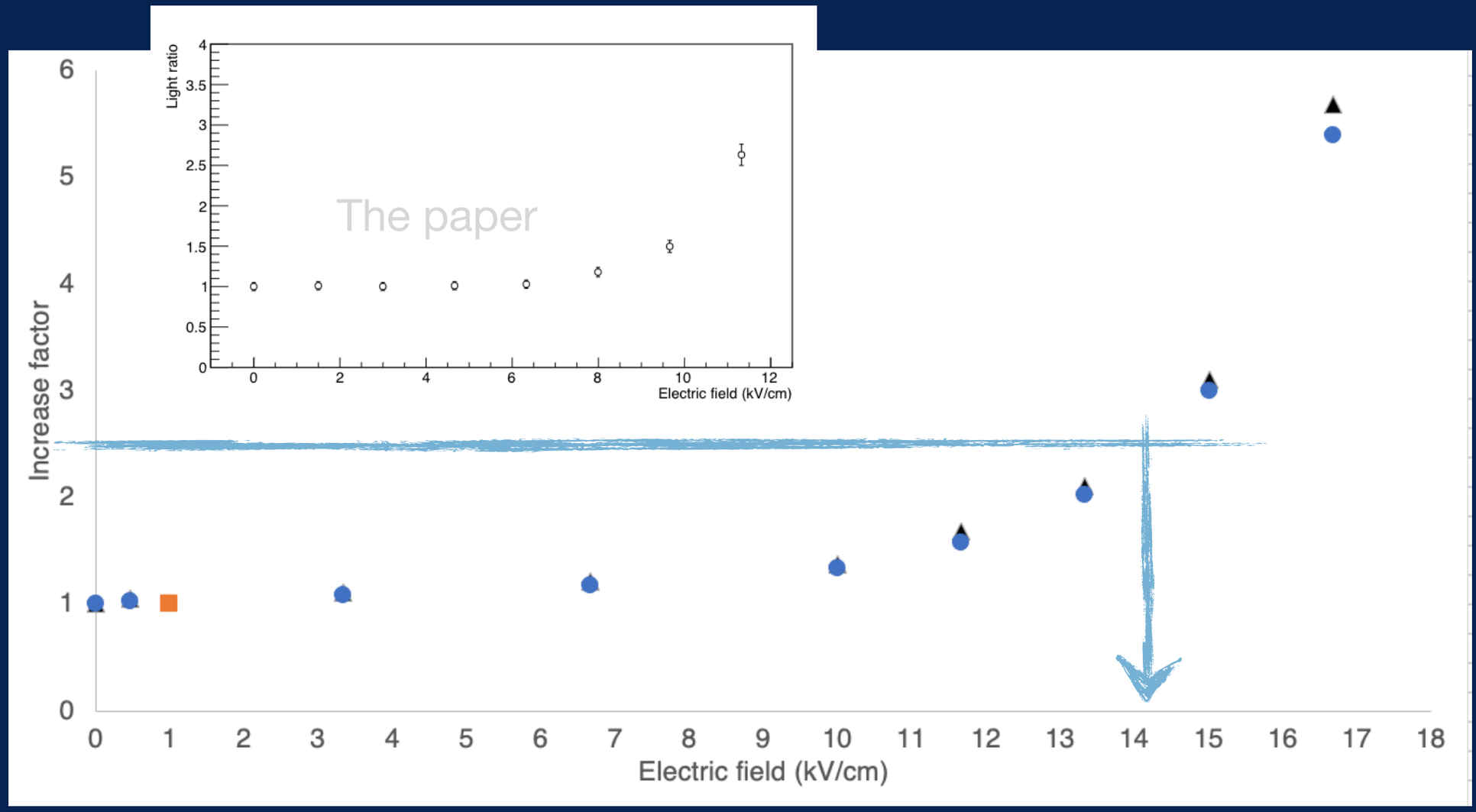
The light



Light is measured in different regions: all measurements in good agreement;

Thanks to the very good quality of the mesh, we E_h explored up to value of almost 17 kV/cm

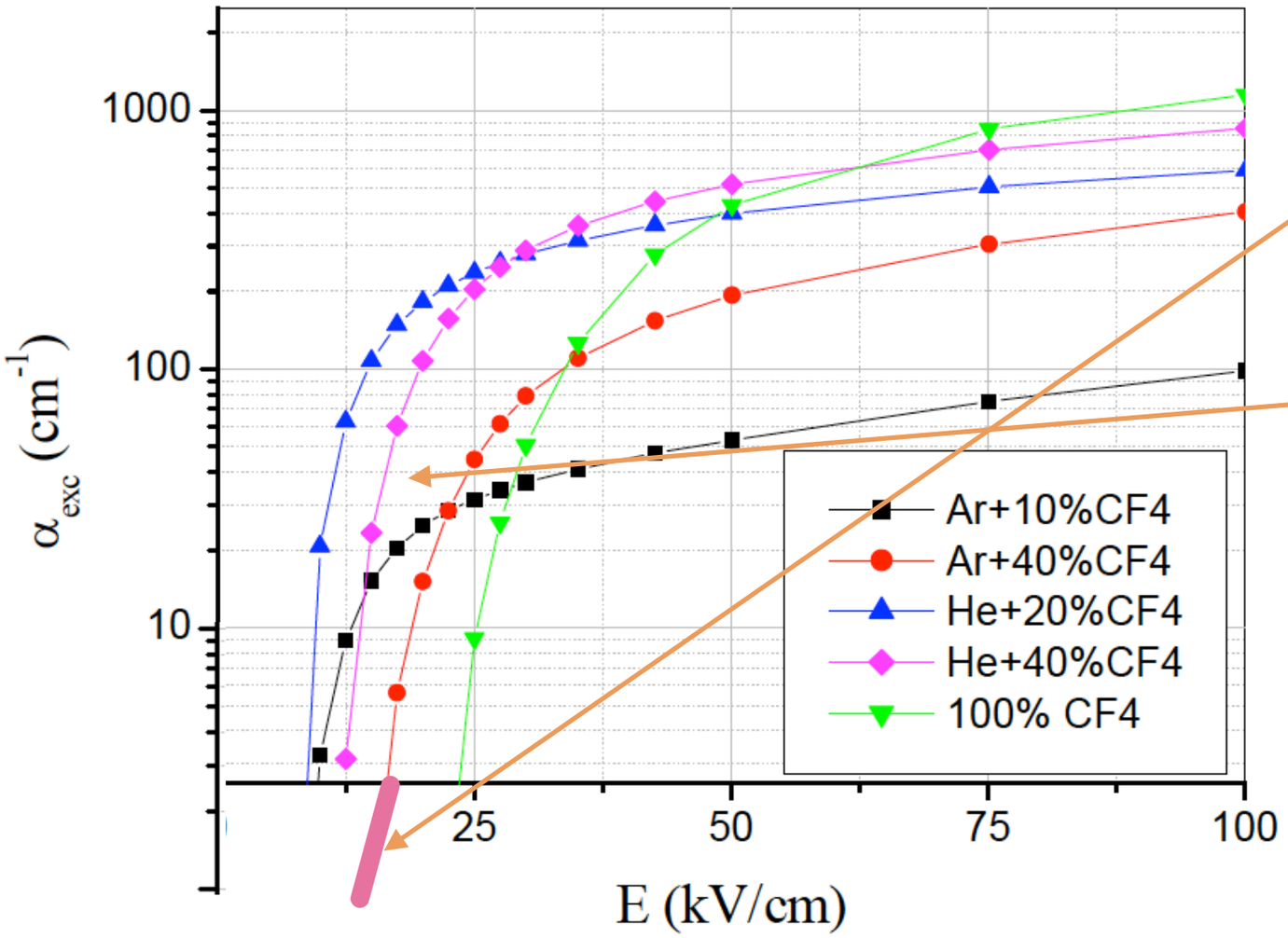
The light (mind the gap)



In order to get a light increase of a factor 2.5, a field of about 14 kV/cm is needed;

In the paper setup, with a V_{MESH} of 3400 V, we reached it with a gap of about 2.5 mm (in medium stat virtus)

The light



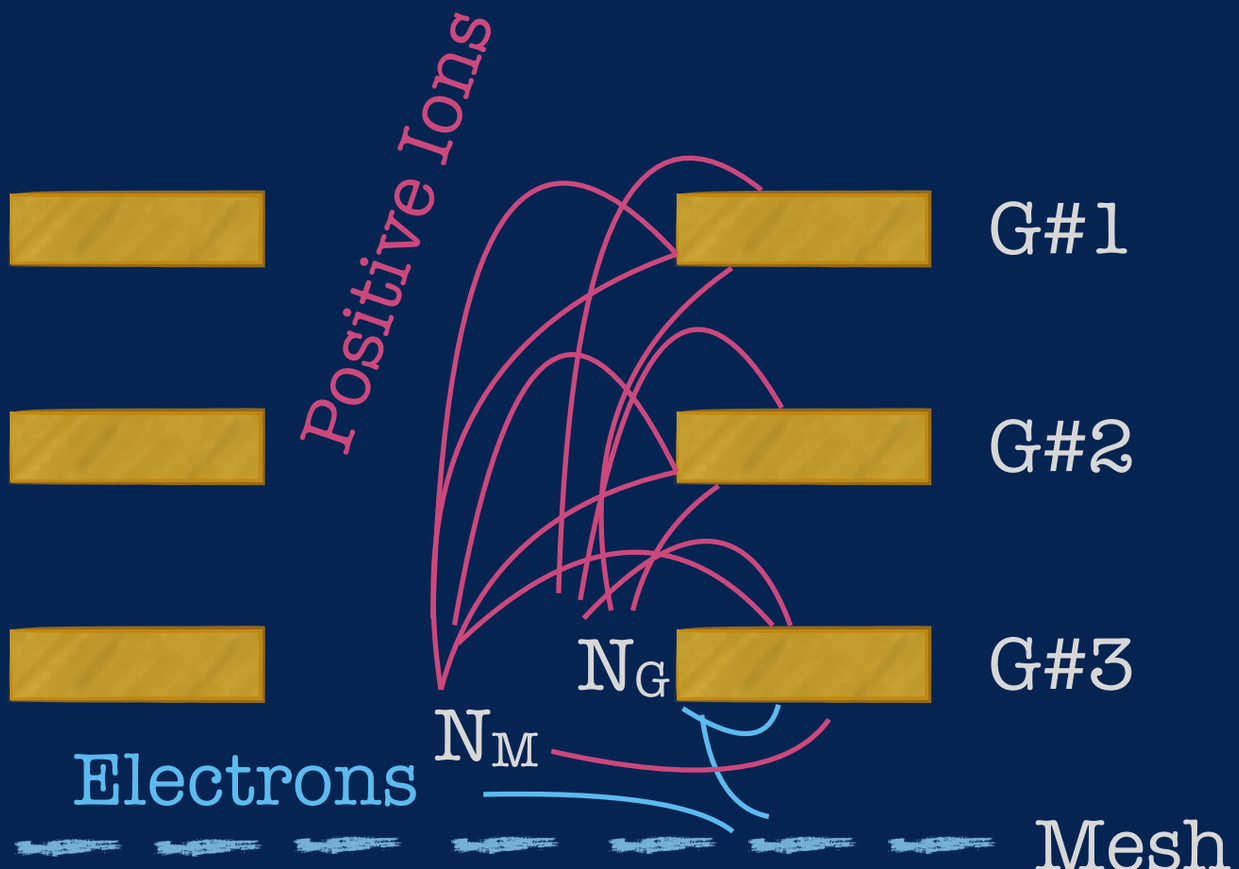
The increase of light production has a lower dependence on the Electric field than expected data do;

For high E values, produced photons are 10 times lower than expected;

I don't know how reliable the simulated values is;

Overall, out data are, at least, within the plot frame

The current



Let's assume all charges are produced in GEM#3 (N_G) and, in case, in the gap above the Mesh (N_M);

ϵ = electron extraction efficiency from GEM#3;

α = fraction of ions reaching GEM #1 and #2;

β = fraction of ions collected on GEM #3D;

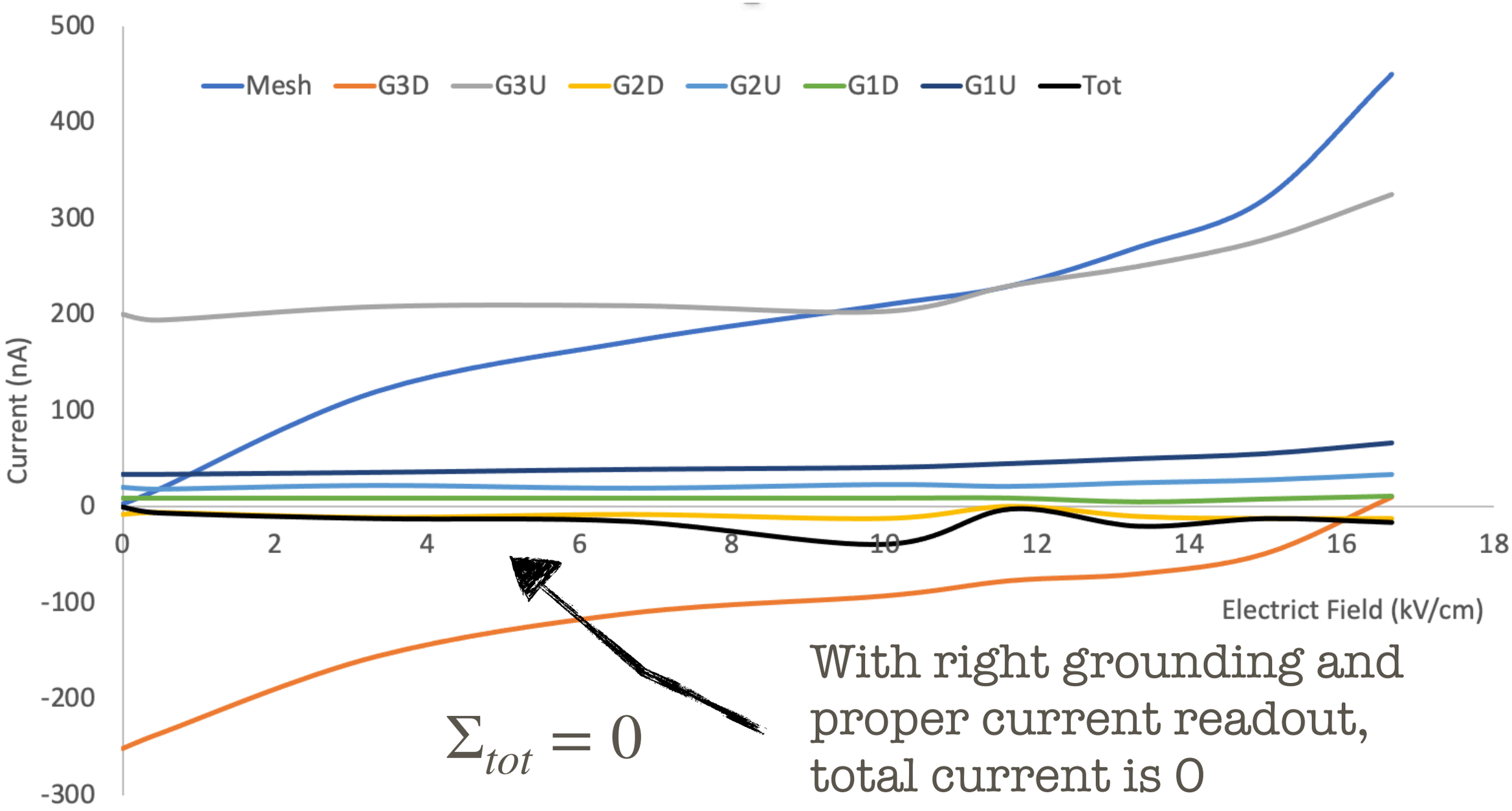
$$I_{3D} = -(1-\epsilon) \times N_G + \beta N_M$$
$$I_M = -\epsilon N_G - N_M$$
$$I_{3U} = (1-\alpha)[N_G + (1-\beta)N_M]$$
$$I_{21} = \alpha[N_G + (1-\beta)N_M]$$

In general, we expect $\Sigma_{tot} = 0$
and in particular $I_M + I_{3D} = -(I_{3U} + I_{21})$
(equations are not independent)

$$\alpha = \frac{I_{21}}{I_{3U} + I_{21}}$$

If $N_M = 0$ (no gain because of the Mesh) $I_{3D} + I_M = -(I_{3U} + I_{21}) = -N_G$

The current



$$\Sigma_{tot} = 0$$

With right grounding and proper current readout, total current is 0

Simple model

Actually, N_G (if any) would depend on N_M:

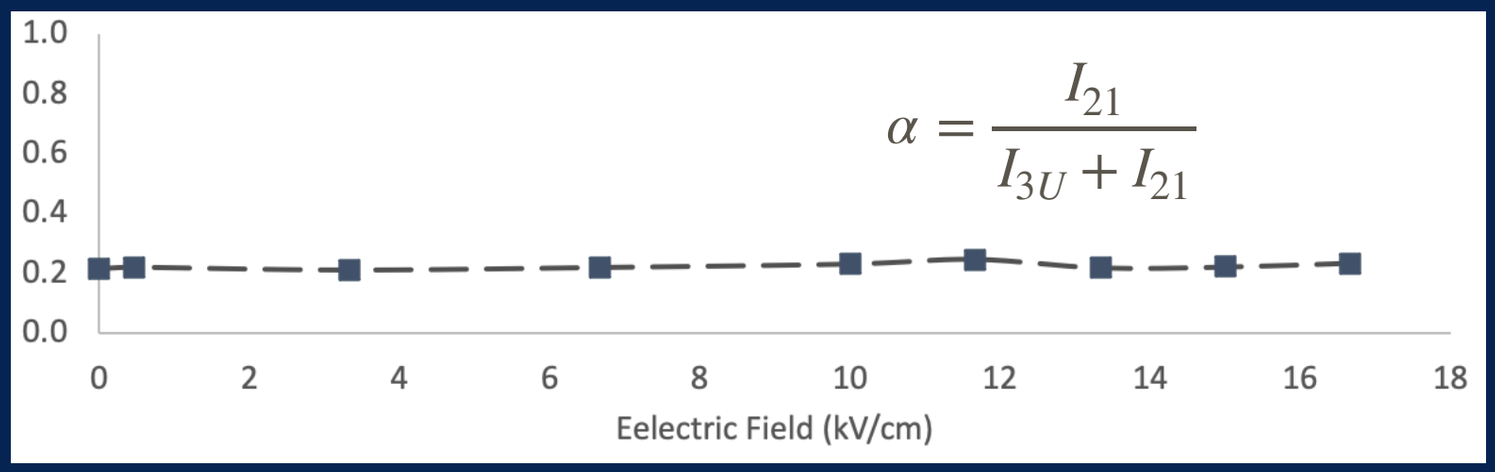
$$N_M = \epsilon N_G \cdot e^{\alpha_T E_M} = \epsilon \delta N_G$$

α_T = Townsend coefficient
$\delta = e^{\alpha_T E_M}$ = gain in the gap below the G#3

$I_{3D} = [\beta\epsilon\delta - (1-\epsilon)]N_G$
$I_M = -[\epsilon(1+\delta)]N_G$
$A = I_{3U} + I_{21} = [1 + (1-\beta)\epsilon\delta]N_G$

$I_{3D} + A = [1+\delta]\epsilon N_G$

$I_{3D} + I_M = [\epsilon\delta(\beta - 1) - 1]N_G$

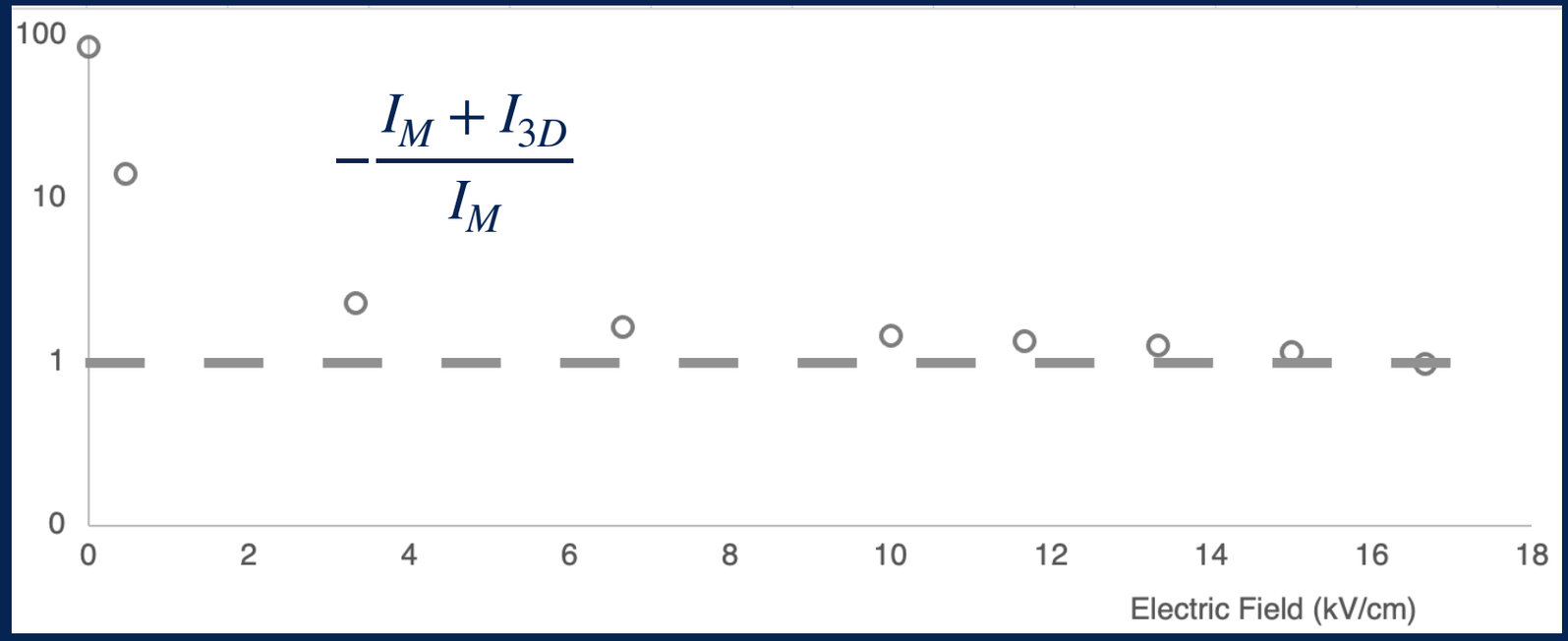


α = fraction of ions reaching GEM #1 and #2;

Simple model

Moreover: $I_M + I_{3D} = N_G[\epsilon\delta(\beta - 1) - 1]$ and $-\dfrac{I_M + I_{3D}}{I_M} = \dfrac{1 - \epsilon\delta(\beta - 1)}{1 + \delta}$

In case $E_M \to \infty$, then $-\dfrac{I_M + I_{3D}}{I_M} \to 1$ if $\beta \to 0$ and $\epsilon \to 1$



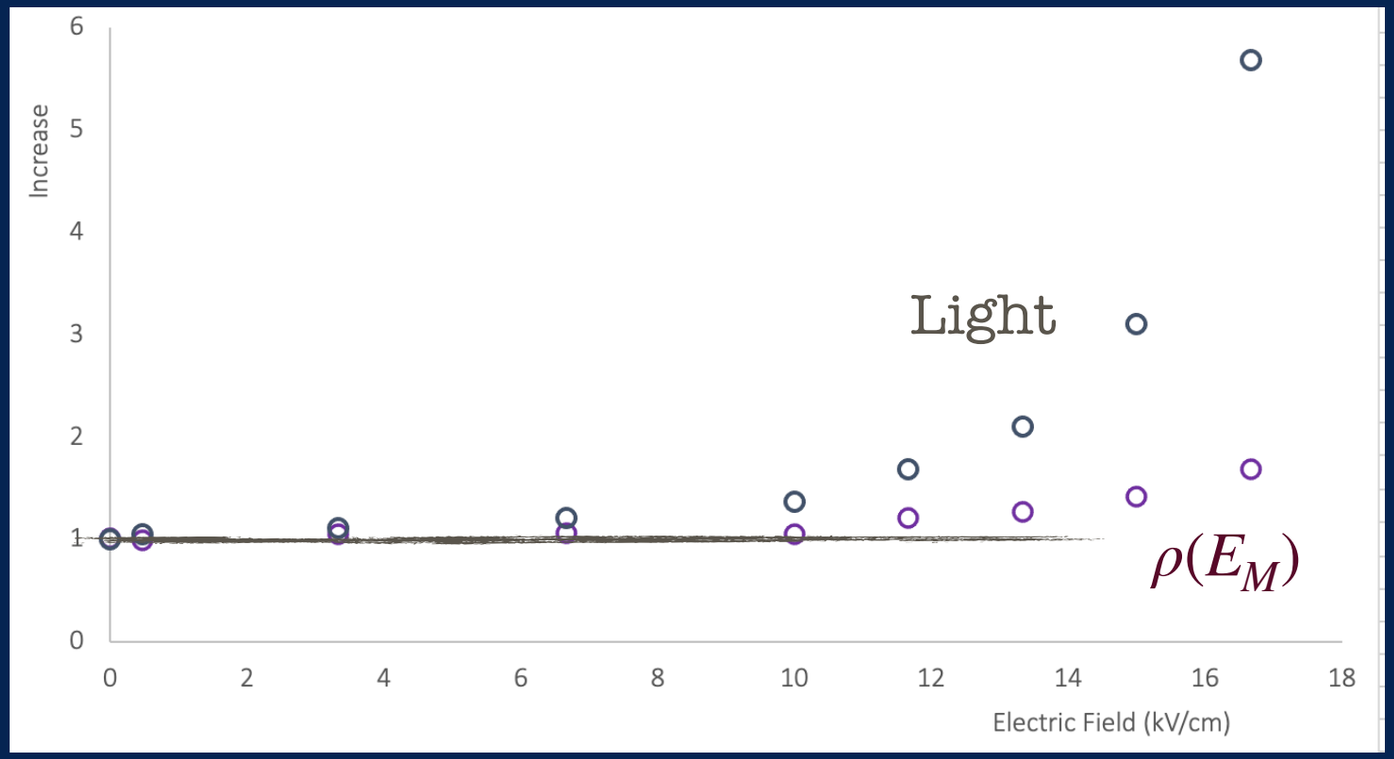
Are we allowed to suppose that for high fields $\beta = 0$ and $\epsilon = 1$?

Simple model

If we assume that at high E_M values $\epsilon = 1 \rightarrow$

$$\rho(E_M) = \frac{(I_{3D}(E_M) + I_M(E_M))}{I_{3D}^0} = \frac{N_G(E_M)[1 + \delta(E_M)]}{N_G^0}$$

Therefore, in the hypothesis $\epsilon = 1 \rightarrow$ $\rho(E_M)$ will represent the total amount of electrons



For electric fields larger than 10 kV/cm, $\rho(E_M)$ starts to be significantly different from 1

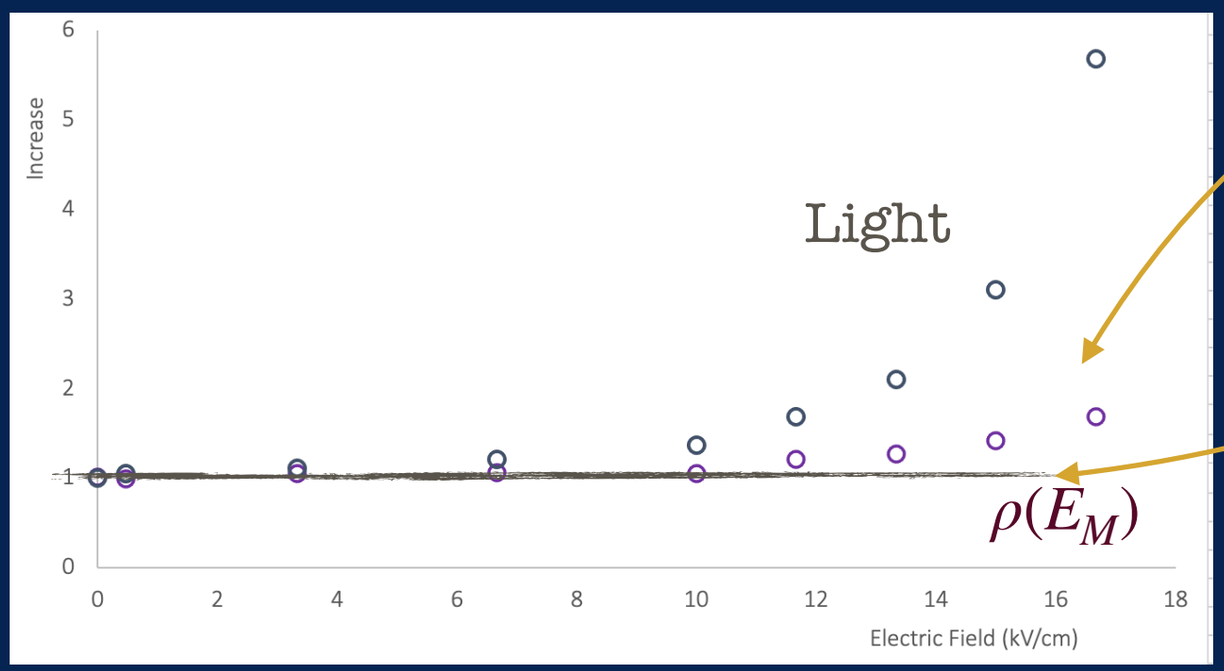
Simple model (part 3)

Are we allowed to suppose that $\beta = 0$?

In this case

$$I_{3D} = [(\epsilon - 1)]N_G$$
$$I_M = -[\epsilon(1+\delta)]N_G$$
$$A = I_{3U} + I_{21} = [1 + \epsilon\delta]N_G$$

$$I_{3D} + A = [1 + \delta]\epsilon N_G$$
$$I_{3D} + I_M = [\epsilon\delta - 1]N_G$$



$$\rho(E_M) = \frac{N_G(E_M)[1 + e^{\alpha_T E_M}]}{N_G^0}$$

GEM#3

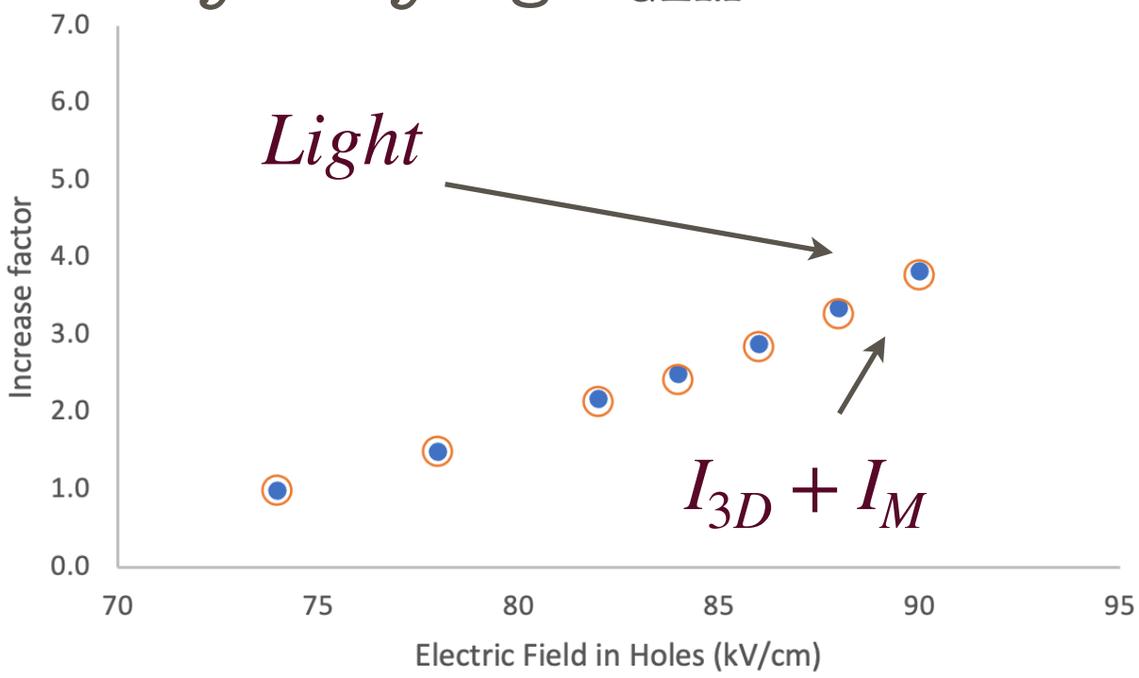
Mesh

Electric field in the holes can be evaluated as

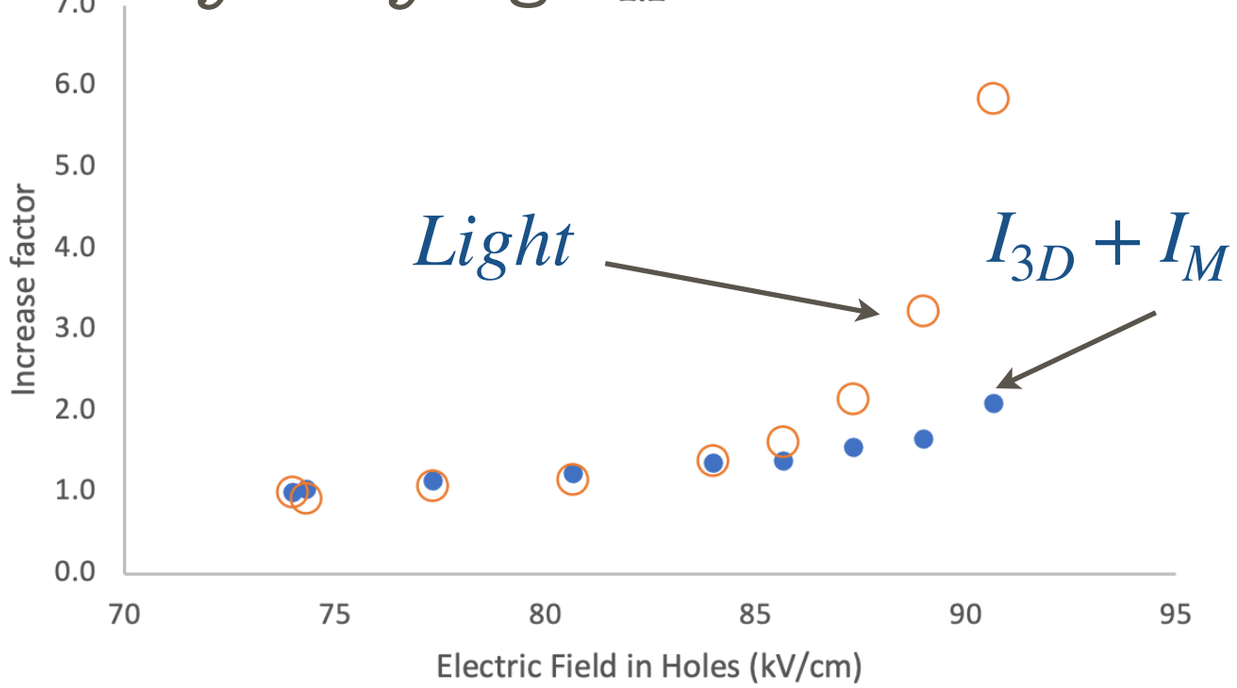
$$E_h = \frac{V_{GEM}}{50\mu m} + E_M$$

We studied the behavior of light and current as a function E_h;

by varying V_{GEM}



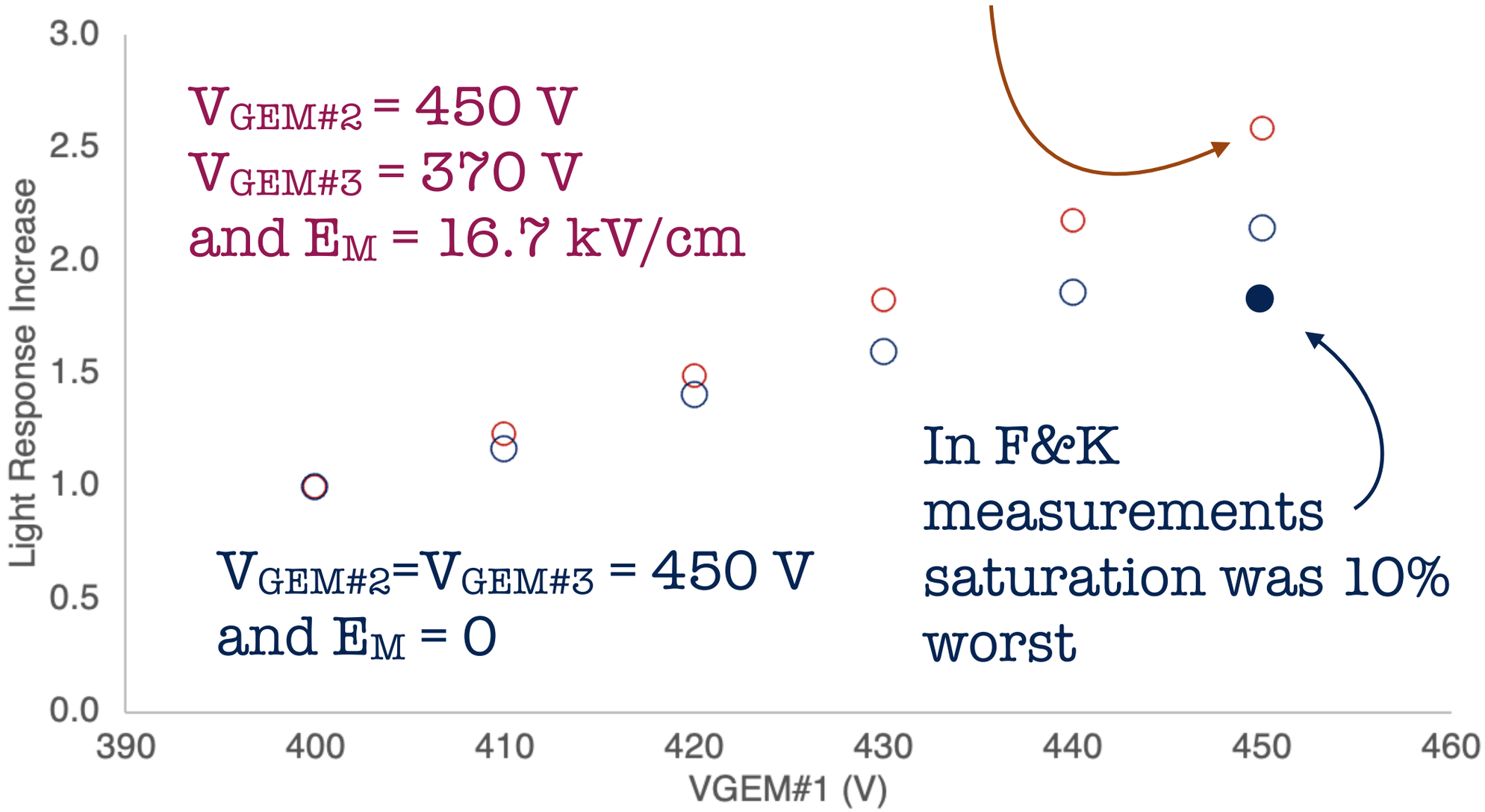
by varying E_M



When increasing V_{GEM} light and current have the same behavior;
Effect of the E_M seems completely different;

Saturation?

According to F&K measurements, expected value was 2.5



Conclusion

Results with flat mesh and better understanding of HV grounding scheme seem to be solid and reliable:

- A light increase of a factor 5-6 was observed;
- A concurrent 1.7 increase in charge was visibile;
- Preliminary analysis indicates this to be due gain in the gap between GEM and MESH;
- The difference between light and charge confirms a light production induced by non-ionizing (or very low-ionizing) electrons.