Latest Updates on the Luminescence Studies with the Strong Field Below the Last GEM

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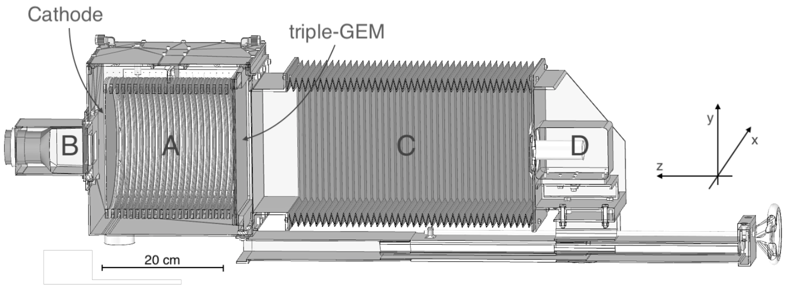
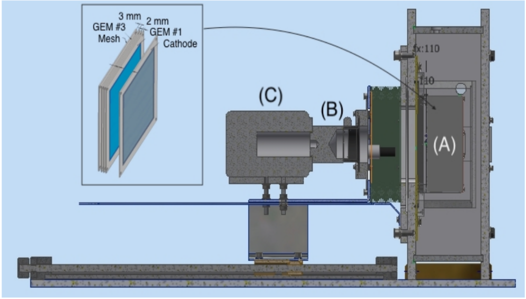
DETECTORS

LEMOn



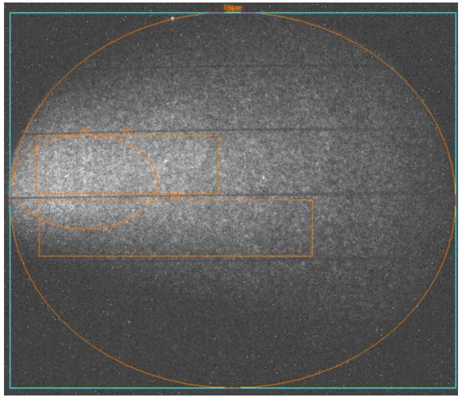
- Large volume and readout area
- ITO glass as extra electrode (T=0.9)
- Very intense ^{55}Fe source which allows to measure
  - average light output
  - Integrated charge from the power supply

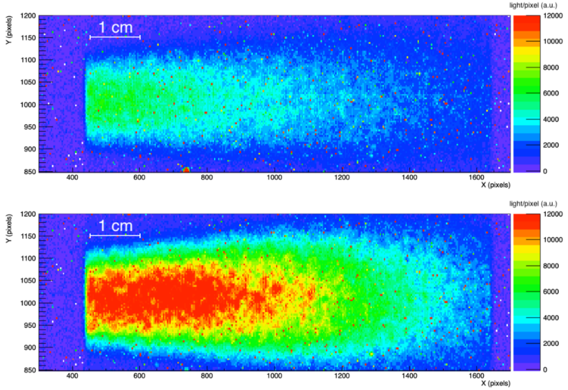
MANGO

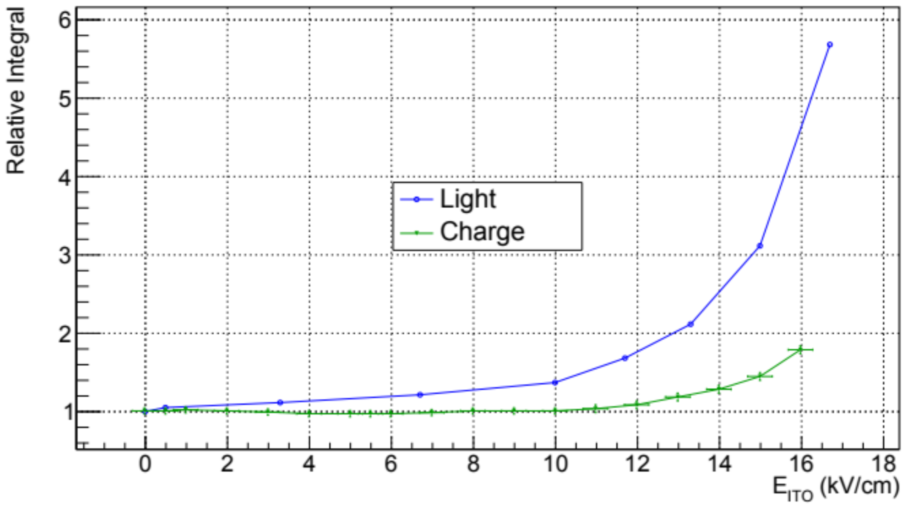


- Small 10 X 10 cm^2 readout area and 0,8 cm drift
- Metallic mesh as extra electrode (T=0.55)
- Low activity ^{55}Fe source which allows to measure event by event the light from the ^{55}Fe interactions

LEMON

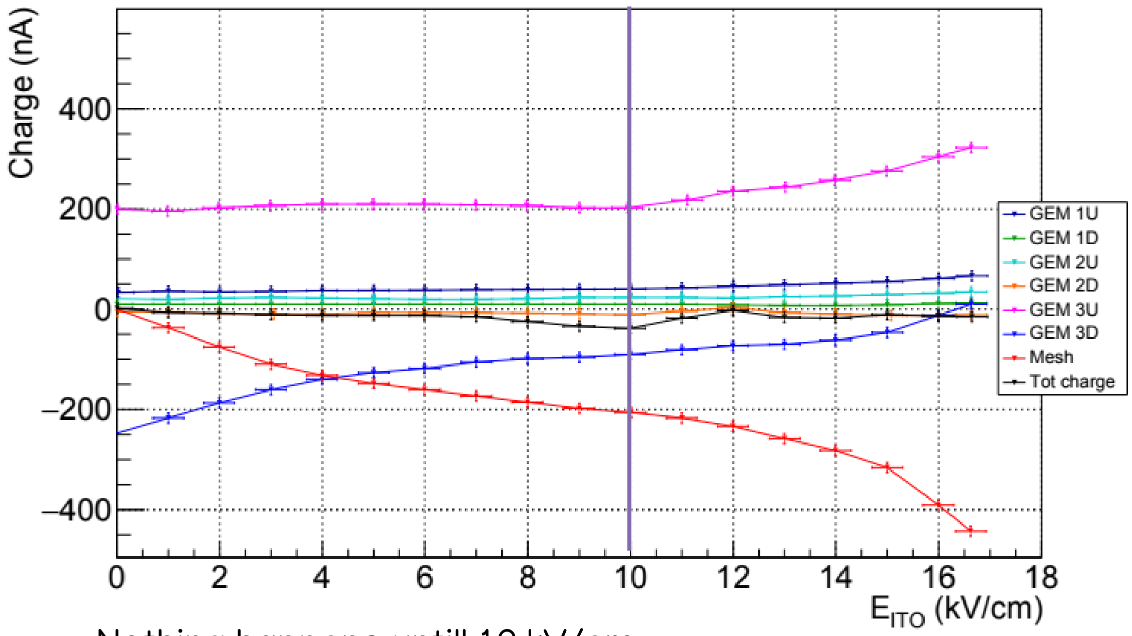






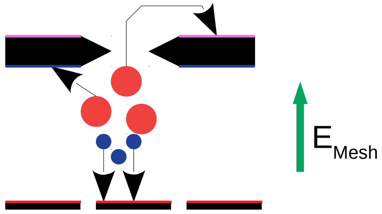
Light increment far exceeds the extra charge produced

Charge Measurements



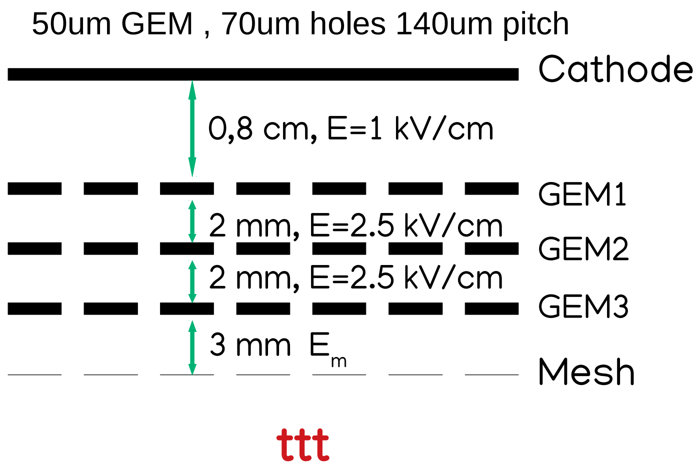
- Nothing happens untill 10 kV/cm
- Above 10 there is a rise in charge → **Charge is produced**
- The amount of charge created can be evaluated from the mesh after taking into account for the sharing of electrons between 3D and mesh

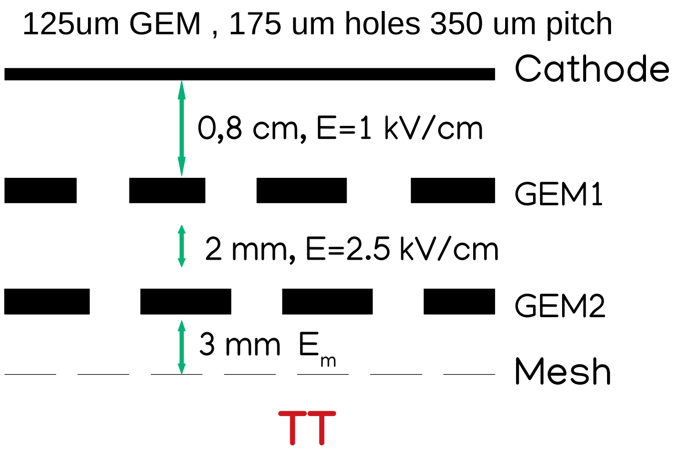
- Total sum of the charge is zero (black)
- 3U collects ions from 3rd stage of amplification (magenta)
- Mesh (red) and 3D (blue) share the electrons generated by the amplification
- If any new charge is generated in the induction:
  - 3D and 3U collect the ions
  - Mesh only collects electrons

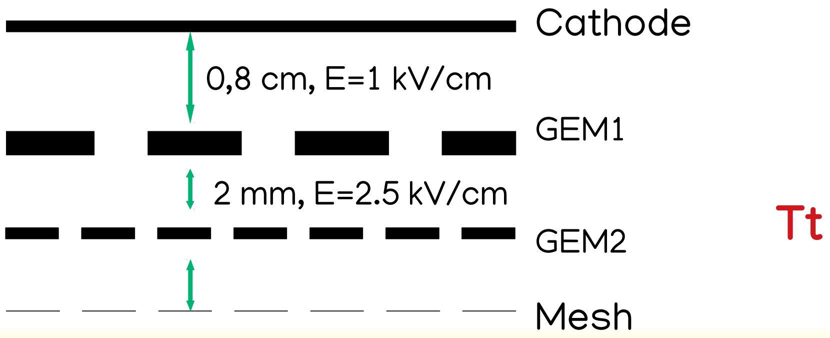


MANGO Different GEM stack configurations

- Different combinations of GEM thicknesses and number of GEMs were implemented in MANGO.
- Also helium content was increased from 60 up to 80 %

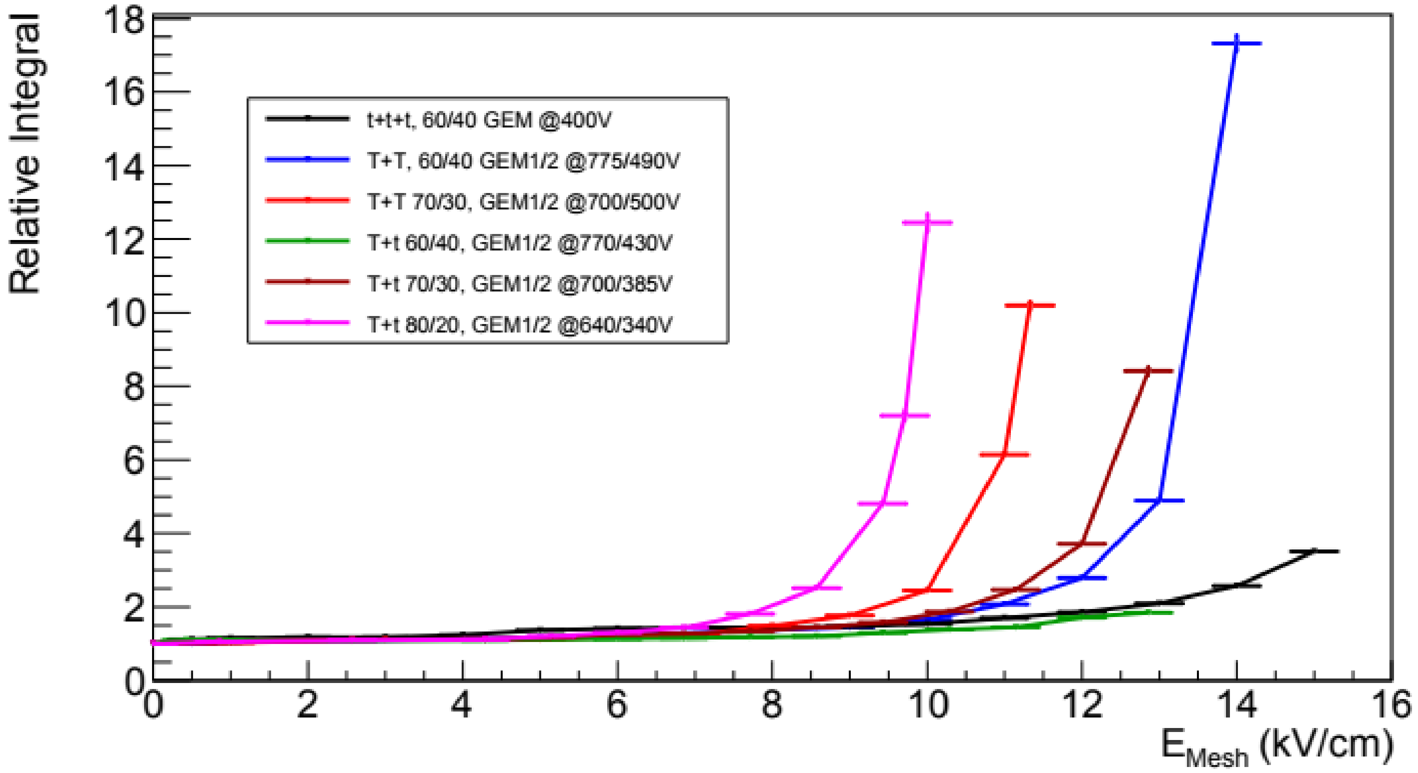






Induction Field: Break Point

- The reduction is applied to all the dataset

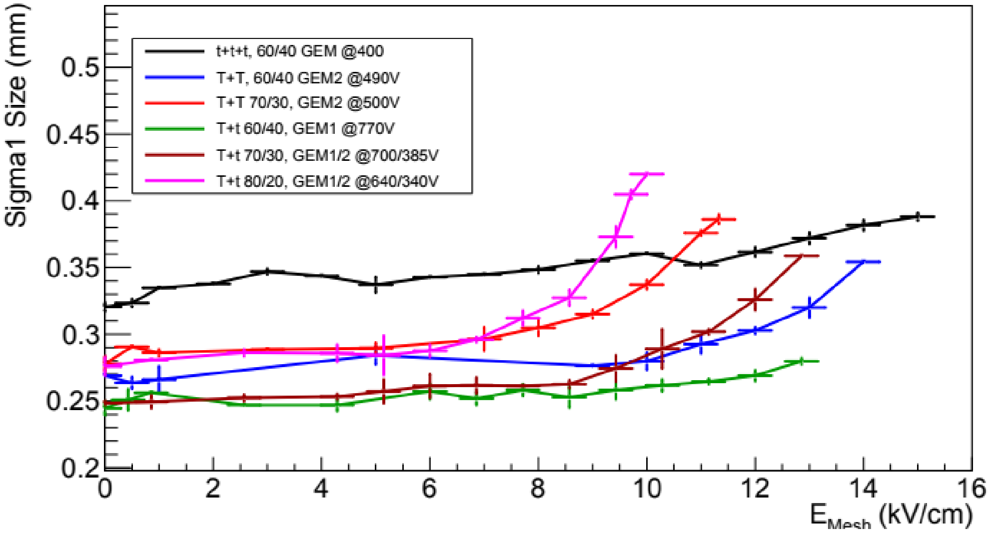


The intensity of the light increase seems to depend on the last GEM

The gas affects the E_{mesh} needed to initiate the phenomenon

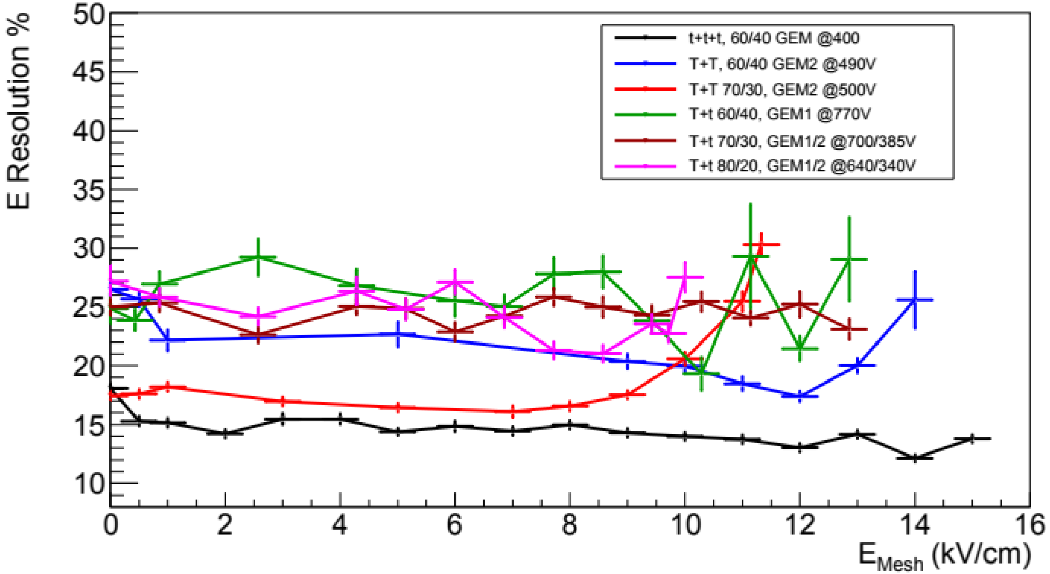
Energy Resolution

Diffusion



- From the breaking point the spot size increases
- Expected as extra light is generated out of the focus

Energy res



- Energy resolution is constant with field if the last GEM is thin
- At the breaking point the thick GEMs have a clear worsening of the resolution

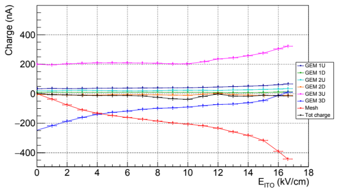
Charge Produced Very Close to the GEMs

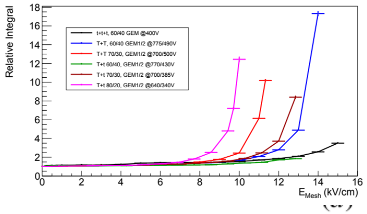
- The hypothesis: the induction field is generating a region few tens of micrometers were the field becomes extremely strong and charge an light are produced

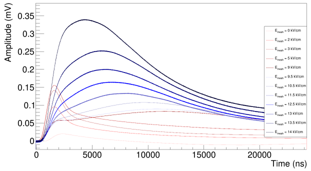
- It explains
  - Why so many ions are collected on 3U
  - Why thick GEMs have higher light production but poorer performances
  - The waveforms behaviour
  - Why there is more light than charge

The field induces just enough energy to start the fragmentation processes

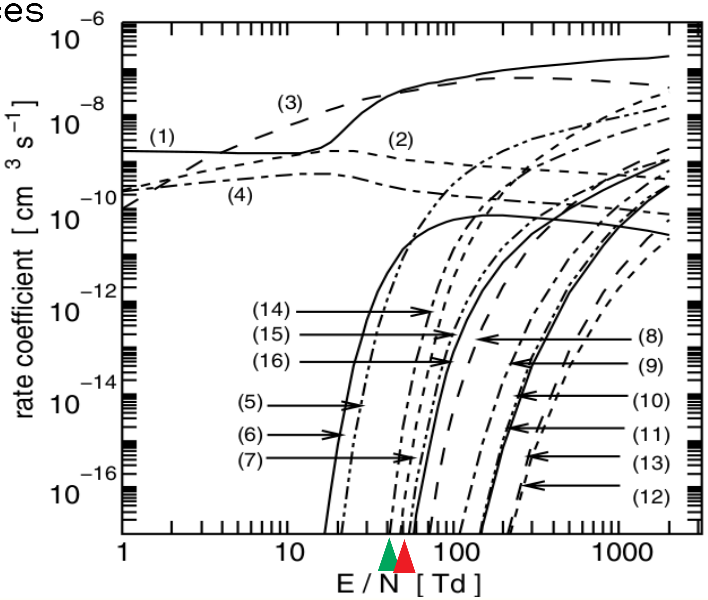
The lower threshold allows to produce more light than charge







Neutral Fragmentation (14)
First ionisation (7)

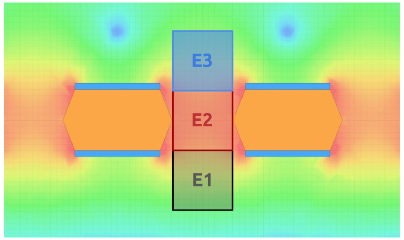


Kurihara, J. Phys. Appl. **33**, 2146 (2000)

Additional study

Improved Maxwell simulations

- The profile of the field close to GEM hole was studied



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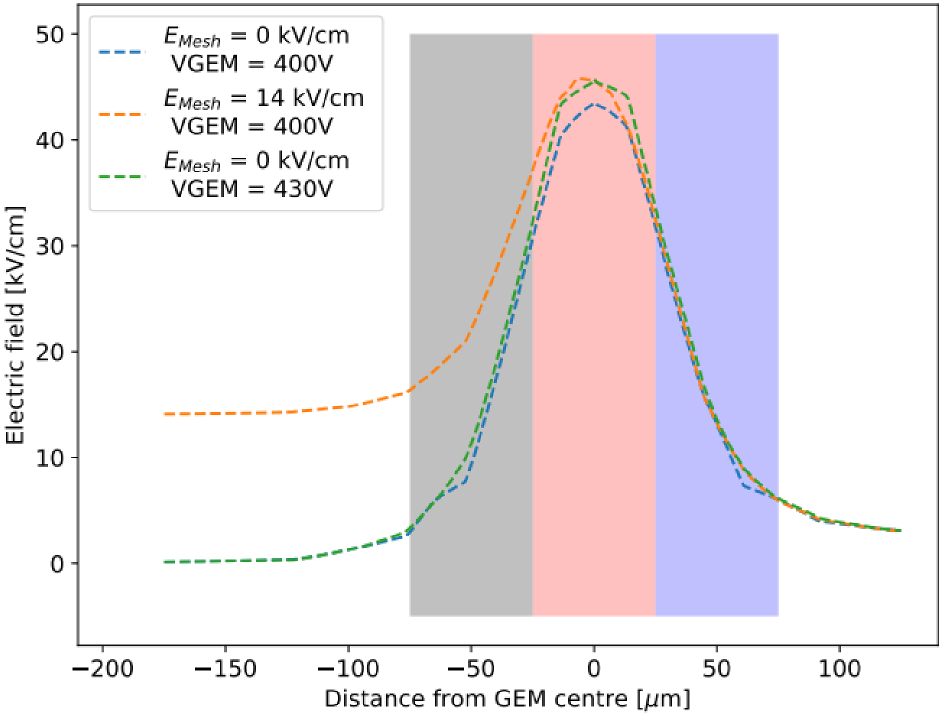

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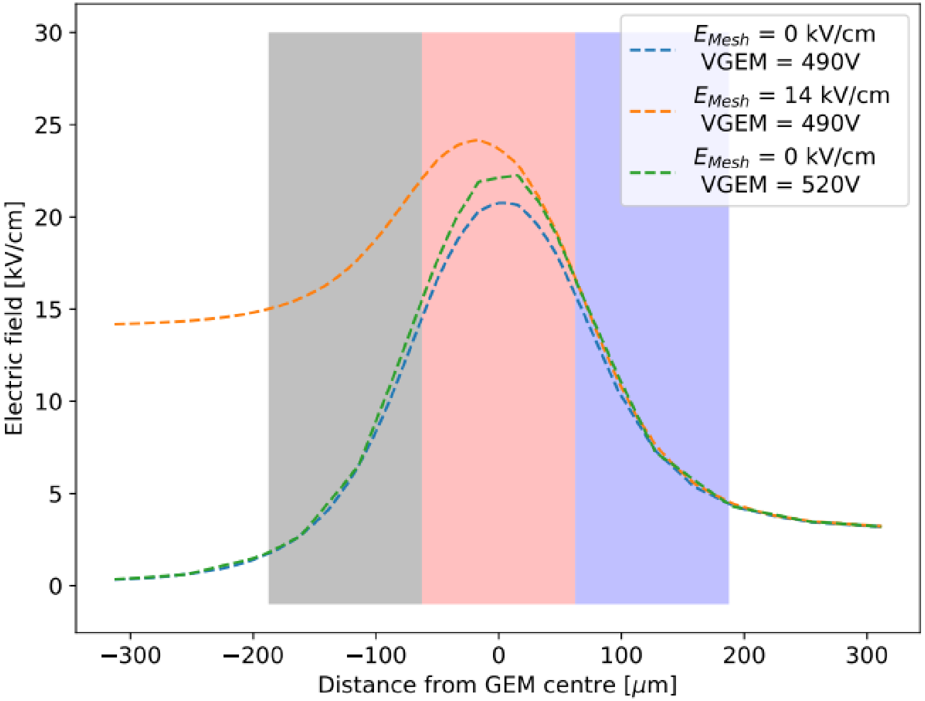

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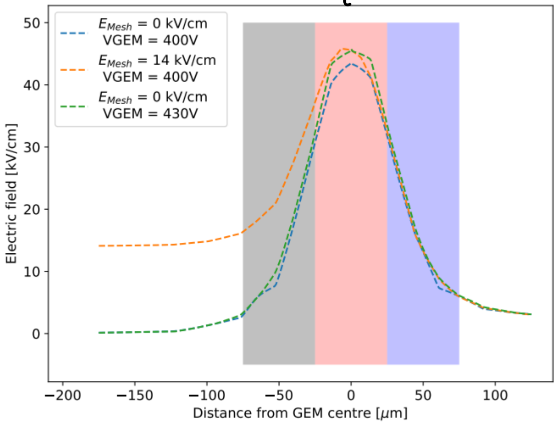

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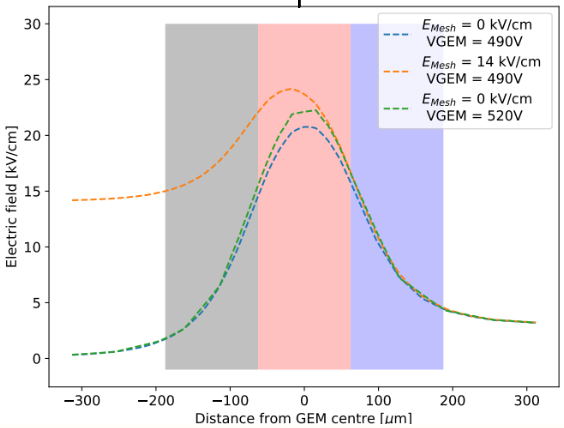
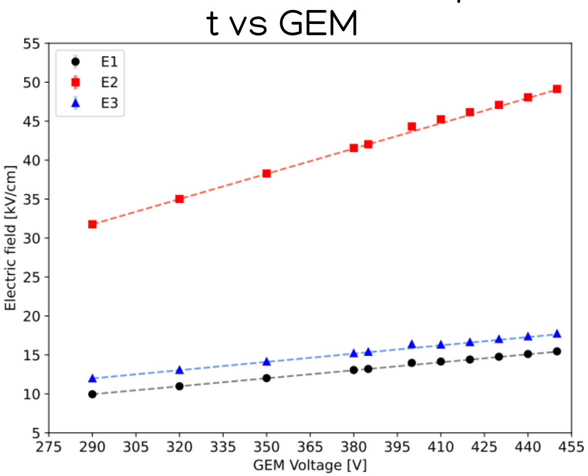
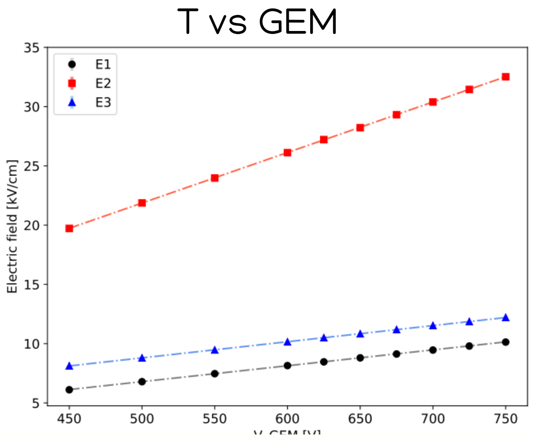


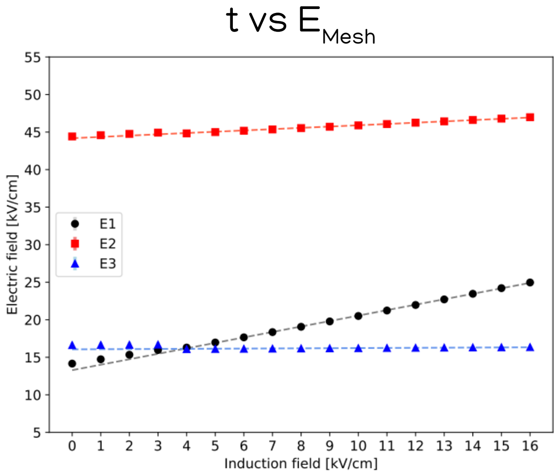
- The volatage across the GEMs modifies the field peak but not the shape
- The induction field changes the field inside the GEM and below
- The derivative of the field decreases
- The region of amplification is widen to below the GEM with in general lower fields (consistent with the larger light production rather than charge)
- The T GEM is more affected

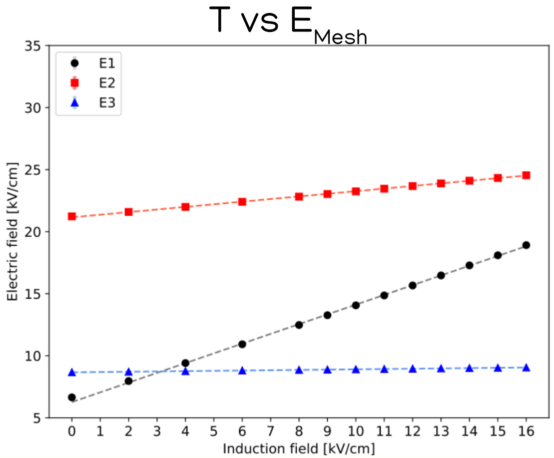
Improved Maxwell simulations

- The average field behaves as studied in the past









Final remarks on 60/40

- The performances with and without the induction field are compared with each other

		Integral	E res (%)	Diff [μm]
ttt	min	9510 ± 40	16.0 ± 0.3	320 ± 4
	max V_{GEM}	28400 ± 110	16.6 ± 0.3	412 ± 5
	max E_{Mesh}	33500 ± 140	13.8 ± 0.3	388 ± 5
TT	min	3410 ± 20	28.0 ± 1.5	260 ± 3
	max V_{GEM}	5090 ± 30	31.0 ± 0.6	255 ± 3
	max E_{Mesh}	58800 ± 300	25.7 ± 0.5	356 ± 5
Tt	min	4600 ± 30	25.2 ± 0.5	245 ± 3
	max V_{GEM}	7700 ± 40	27.8 ± 0.5	245 ± 3
	max E_{Mesh}	11800 ± 50	26.8 ± 0.5	280 ± 4

- The induction field always allows to increase the light output with respect to the same configuration at max VGEM
- TT provides the largest light yield
- Tt has the lowest diffusion
- ttt has the better energy resolution

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- The performances in 3 scenarios are also compared
  - Scenario 0: integral equal to ttt without field
  - Scenario 1: Equal integral for all config
  - Scenario 2: Max light output achieved

		E_{Mesh} [kV/cm]	Integral	E res (%)	Diff [μm]
0	ttt	0 ± 0	9510 ± 40	16.0 ± 0.3	320 ± 4
	TT	12 ± 0.3	9420 ± 40	17.4 ± 0.4	302 ± 4
	Tt	11.1 ± 0.3	9360 ± 40	27 ± 0.5	264 ± 3
1	ttt	3 ± 0.3	11300 ± 50	15.5 ± 0.3	347 ± 5
	TT	12.3 ± 0.4	11300 ± 50	17.9 ± 0.4	307 ± 4
	Tt	12.3 ± 0.4	11300 ± 50	25.0 ± 0.5	273 ± 4
2	ttt	15 ± 0.3	33500 ± 140	13.8 ± 0.3	388 ± 5
	TT	14 ± 0.3	58800 ± 300	25.7 ± 0.5	356 ± 5
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Each configuration excels in one measurable quantity

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Conclusions

- A more detailed profile study of the GEM electric field is performed showing a notable distortion of the electric field below the last GEM

- The addition of the induction field allows to increase the light output of the GEM structure above the limit achievable just enlarging the voltage across the GEMs

- Each configuration excels at a specific measurable quantity: *ttt* energy resolution, *TT* light output, *Tt* diffusion