ANSYS+GarField simulation of CRP induction efficiency, extraction efficiency and effective gain.

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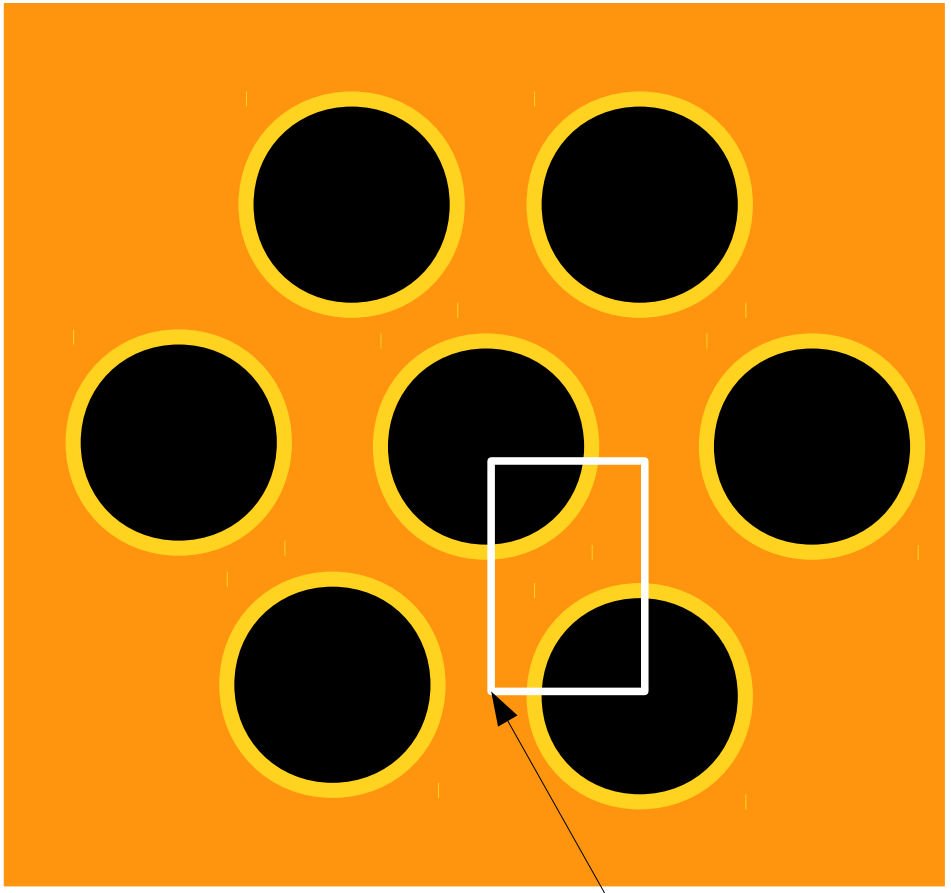
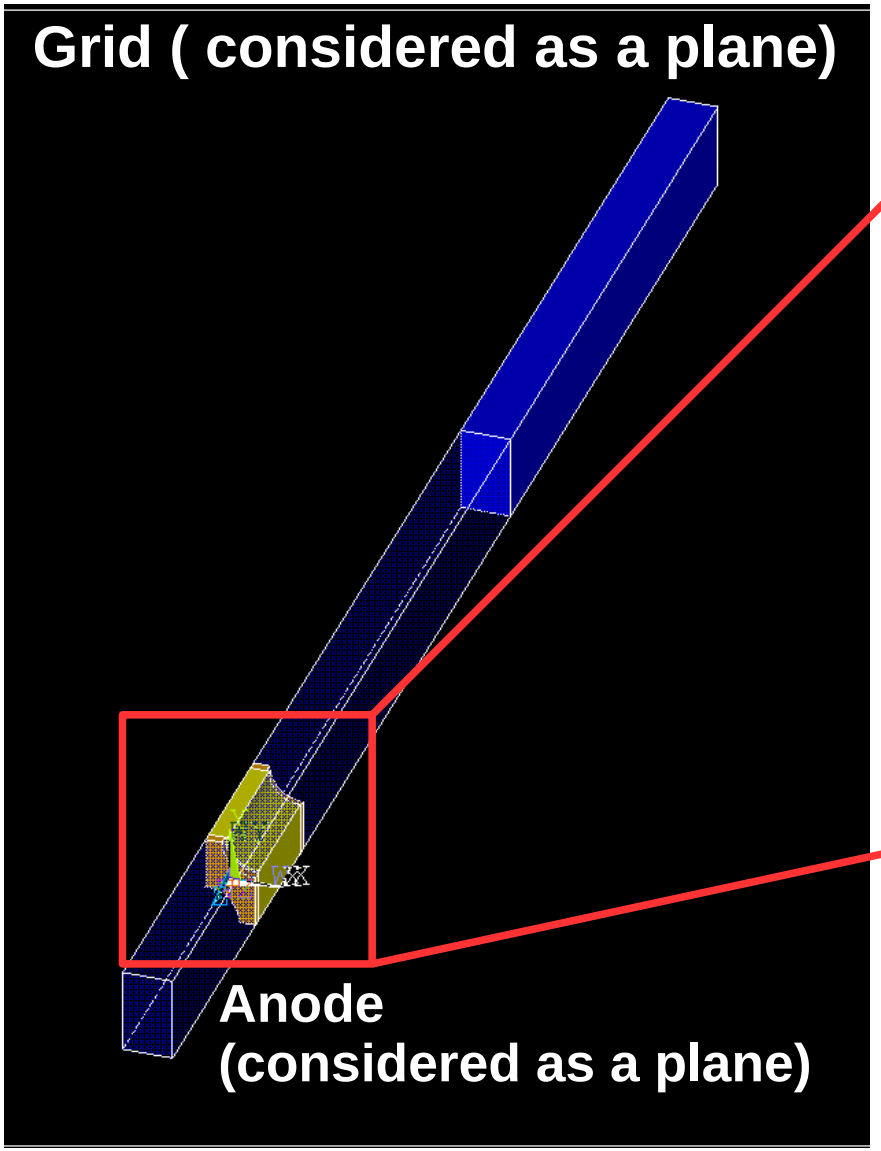
- ANSYS geometry
- GarField input parameters and Microscopic traking
- Definition and results of efficiencies and gain
- Conclusion

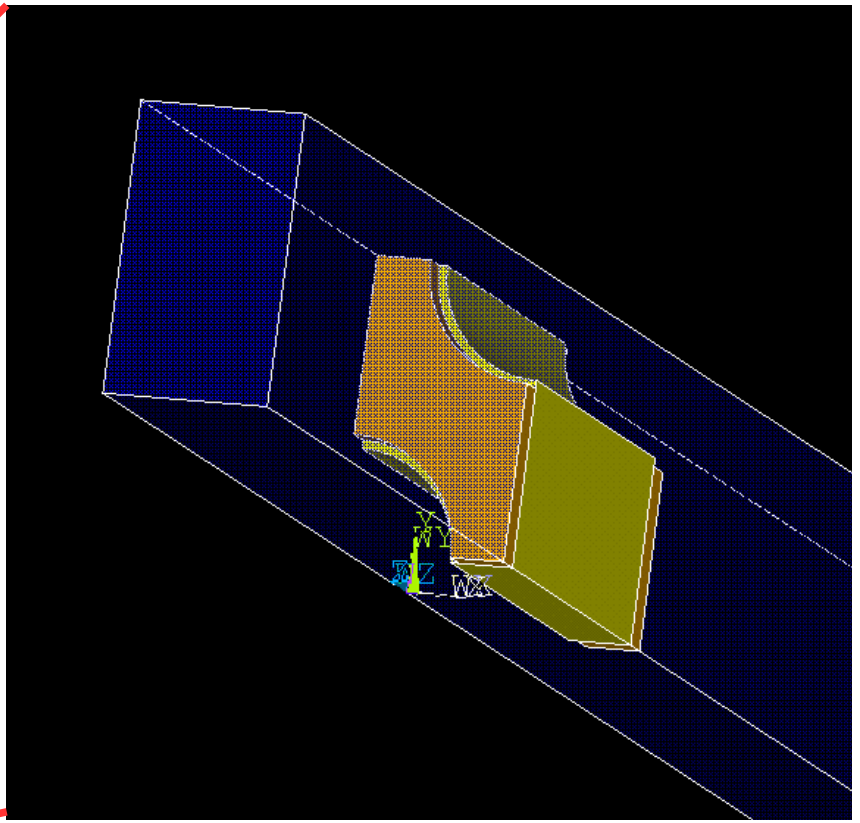
LEM hole geometry



Base element in ANSYS simulation

ANSYS Geometry : simple with symmetry conditions on borders





Symmetry conditions on border give full hexagonal geometry

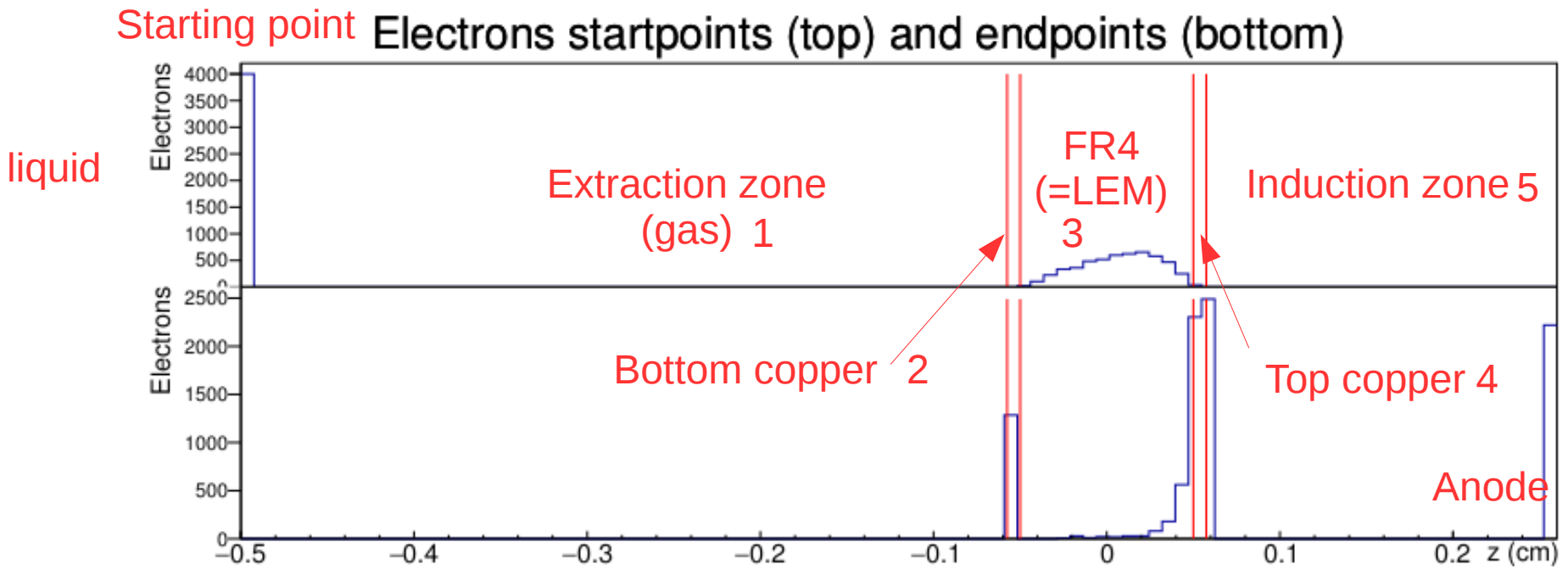
GarField input parameters

- Pressure = 760 Torr
- Temperature = 87K
- 100 % Argon

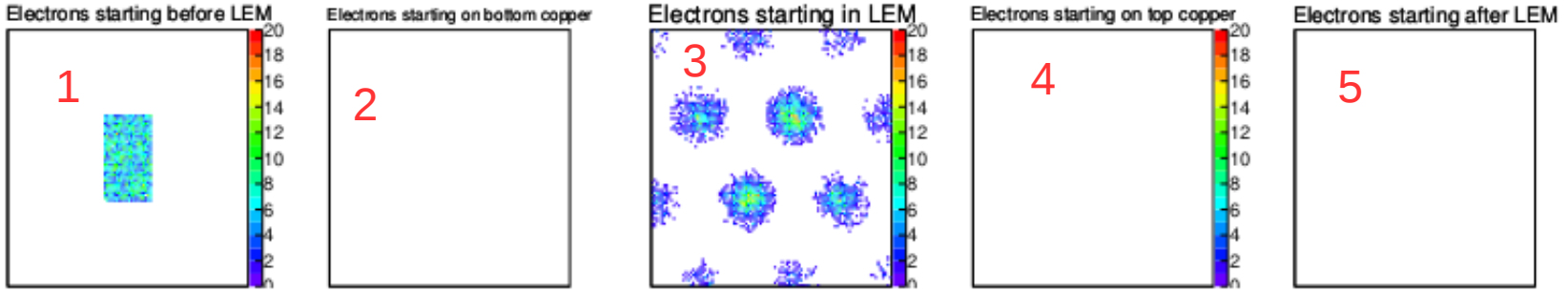
GarField simulation

- Electron starting point : just above liquid (GarField does not simulate drift in liquid)
- Drift and avalanche method : microscopic tracking, uses scattering rates and cross sections to simulate various kinds of collisions
- Also simulates photons emissions and their ionising effect

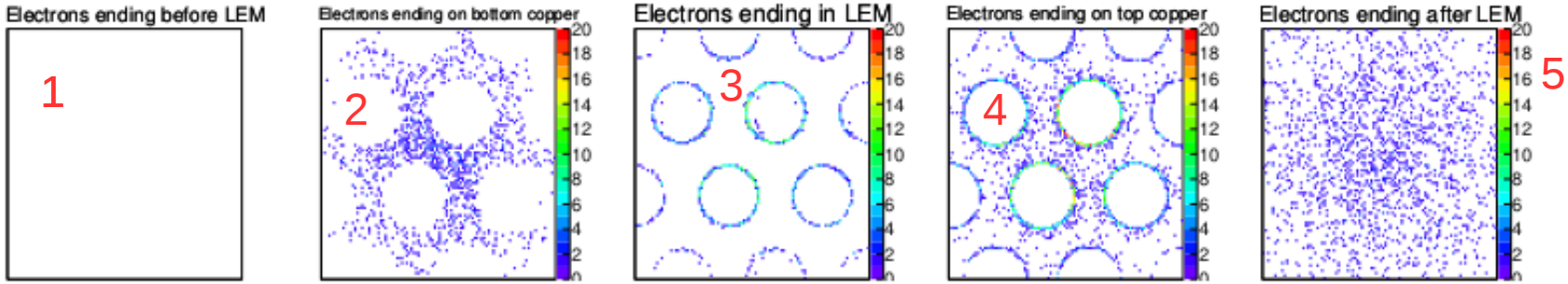
Example with anode=0V, LEM top=200V, LEM bottom = 3000V, Grid = 5500V



Electron startpoints



Electron endpoints



Relevant values and their definition

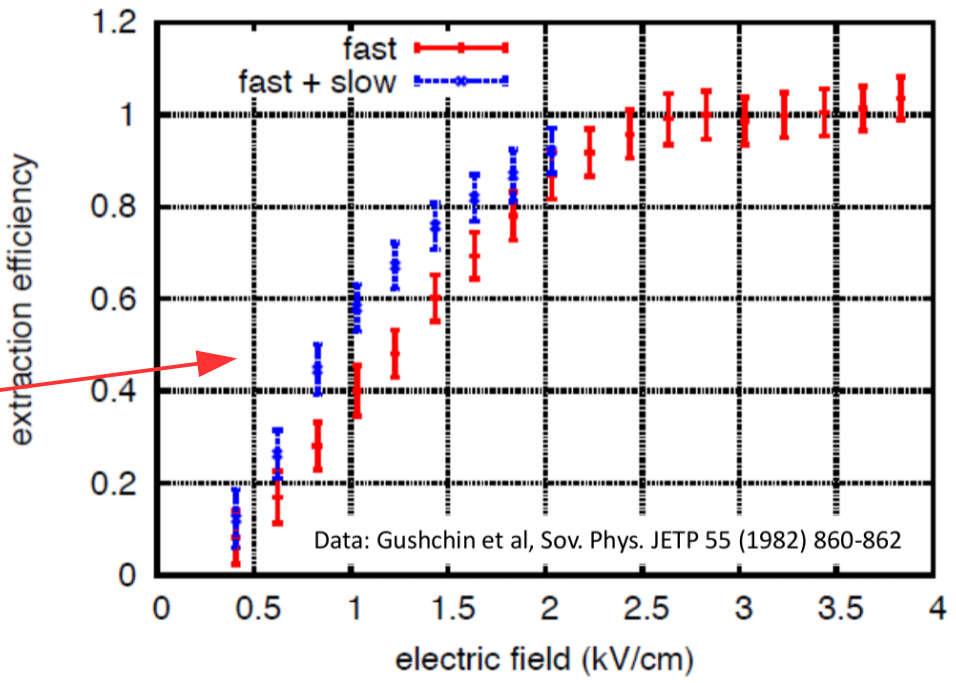
- Induction efficiency = electron at anode / electrons exiting amplification zone (main loss is on top copper)

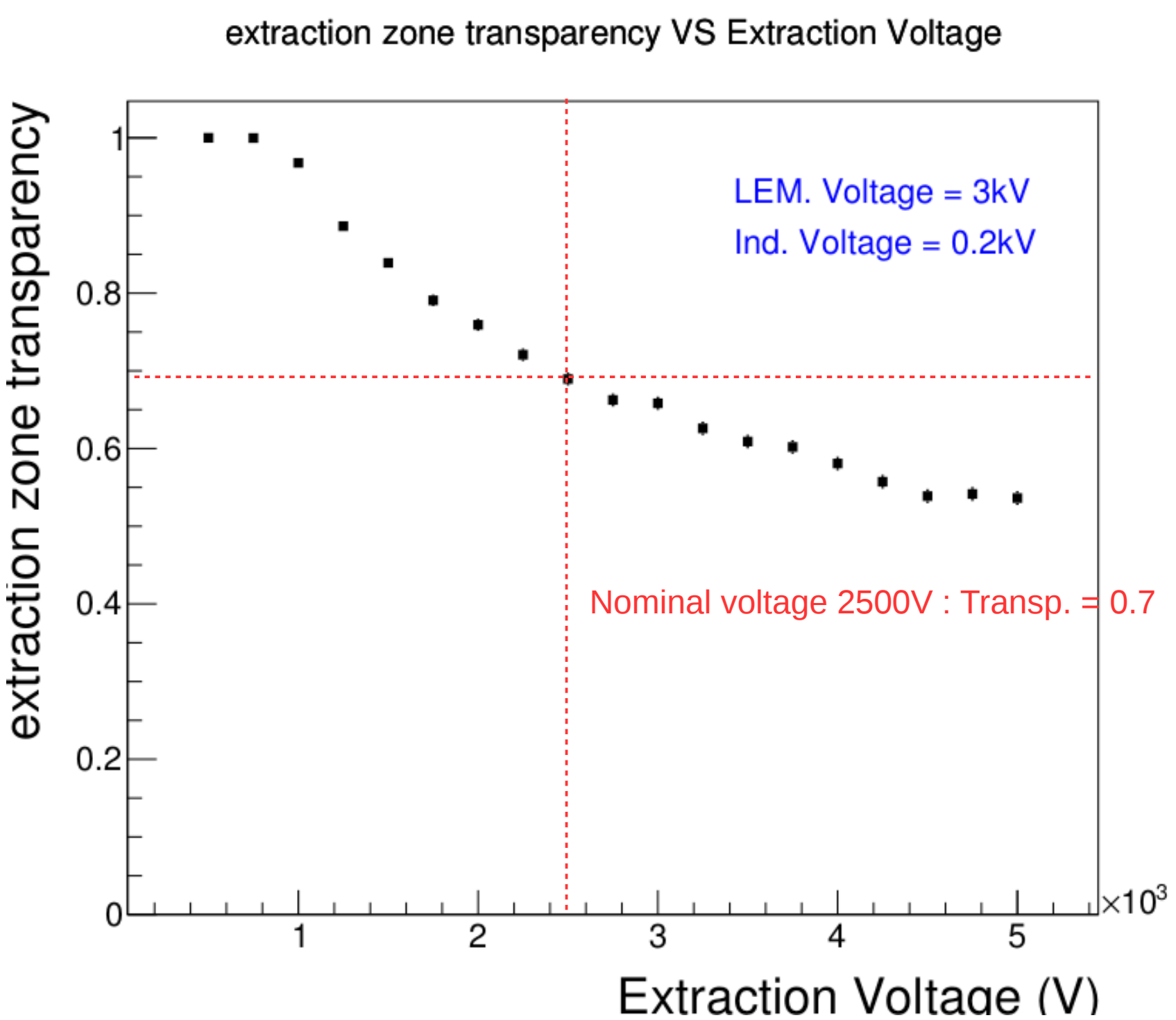
- Extraction zone transparency = electrons reaching amplification zone / electrons generated (main loss is on bottom copper) !!! only in gas !!!

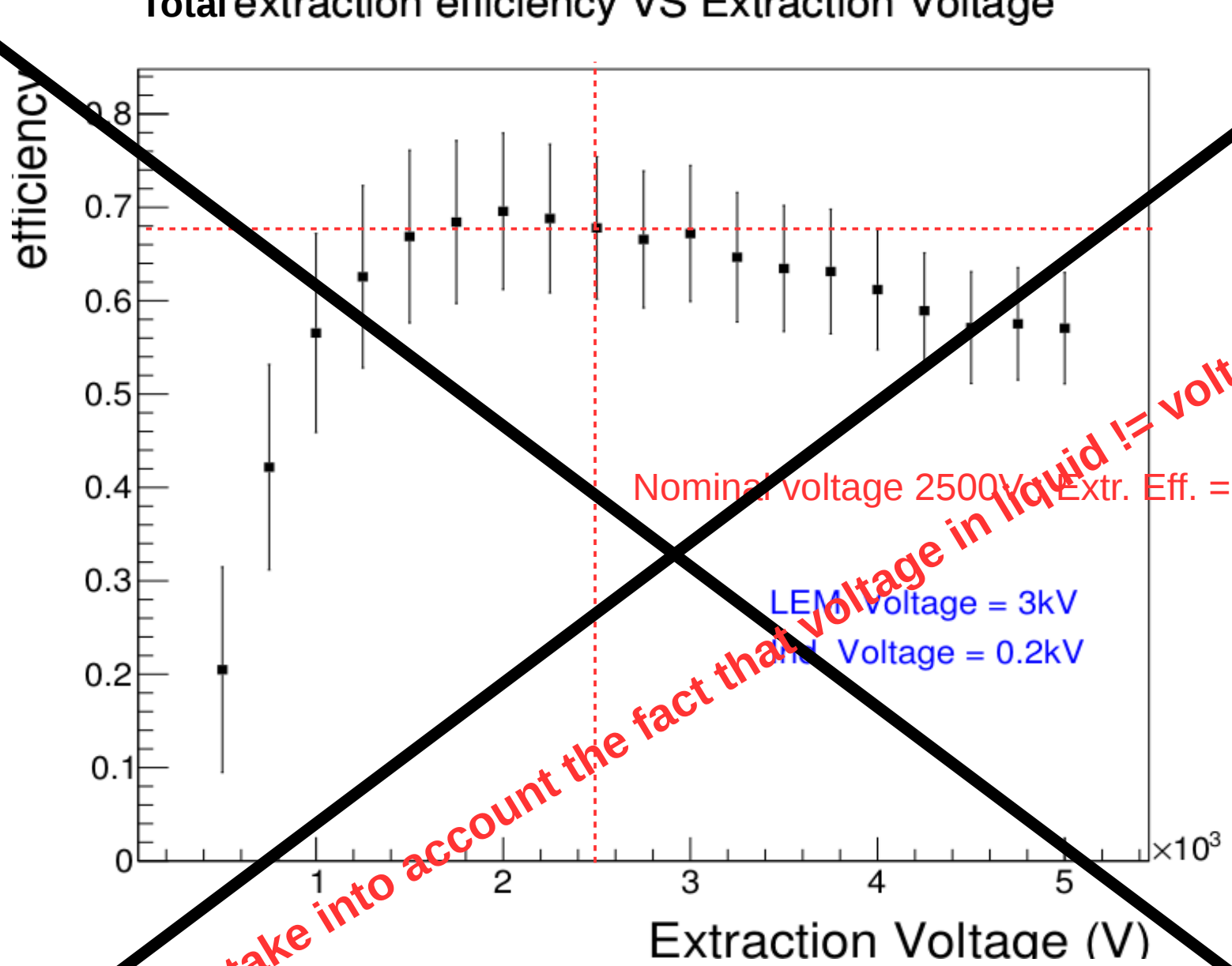
- Total extraction efficiency = transparency convoluted with liquid-gas extraction efficiency

- Effective gain = electrons at anode / electrons generated ***Does not take charging up into account!***

Fig. 22 from TDR



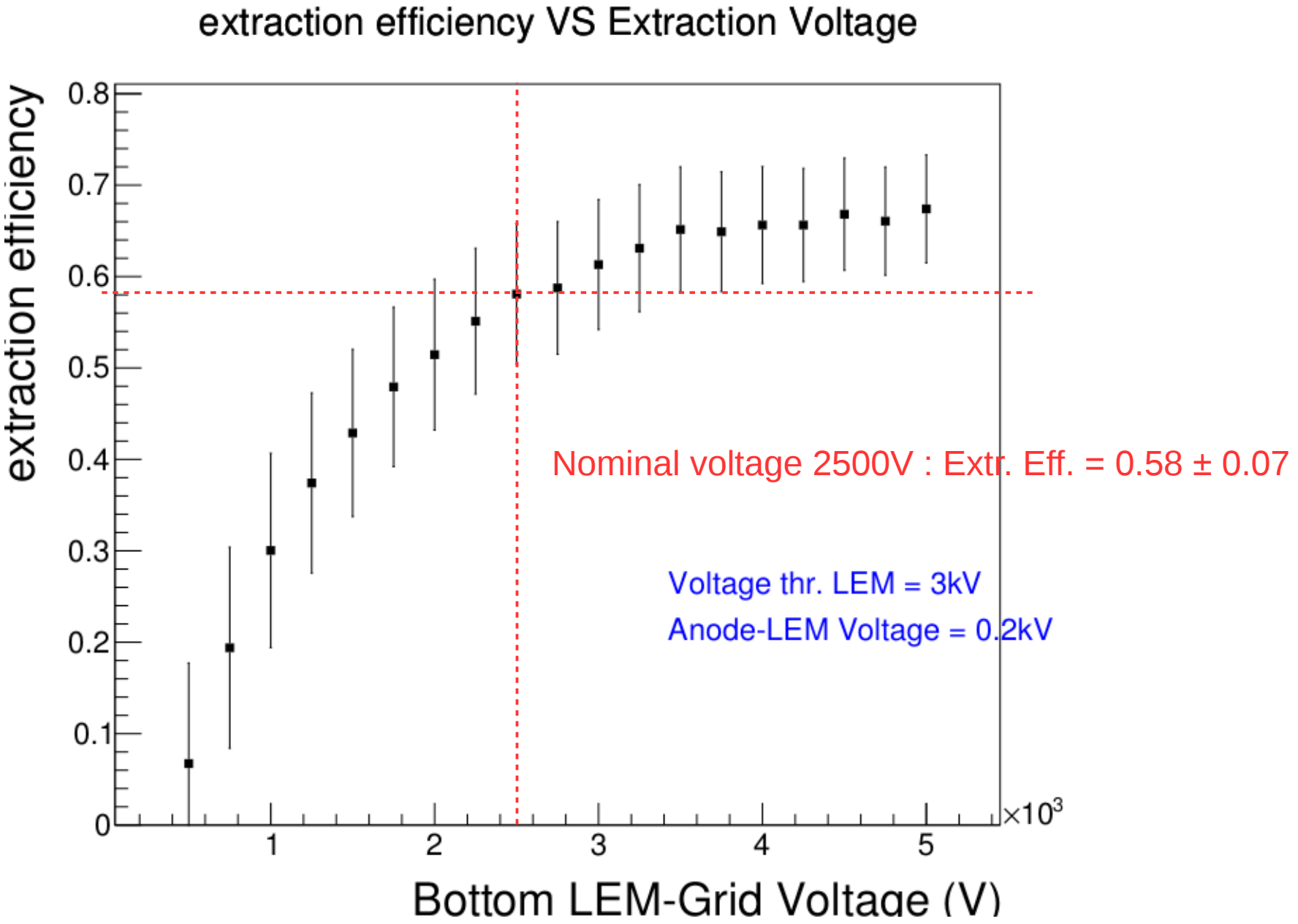

extraction zone transparency VS Extraction Voltage
extraction zone transparency
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
×10³
Extraction Voltage (V)
LEM. Voltage = 3kV
Ind. Voltage = 0.2kV
Nominal voltage 2500V : Transp. = 0.7



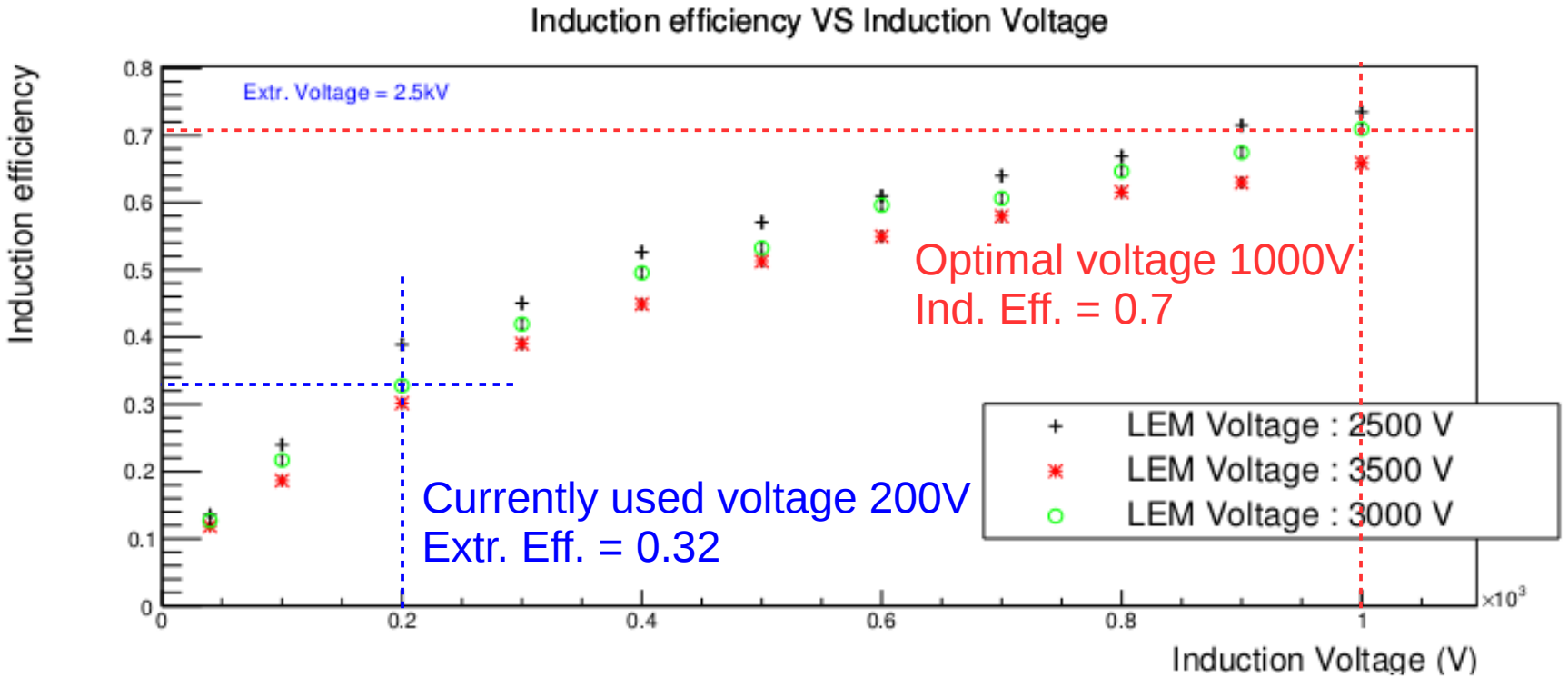
Did not take into account the fact that voltage in liquid != voltage in gas

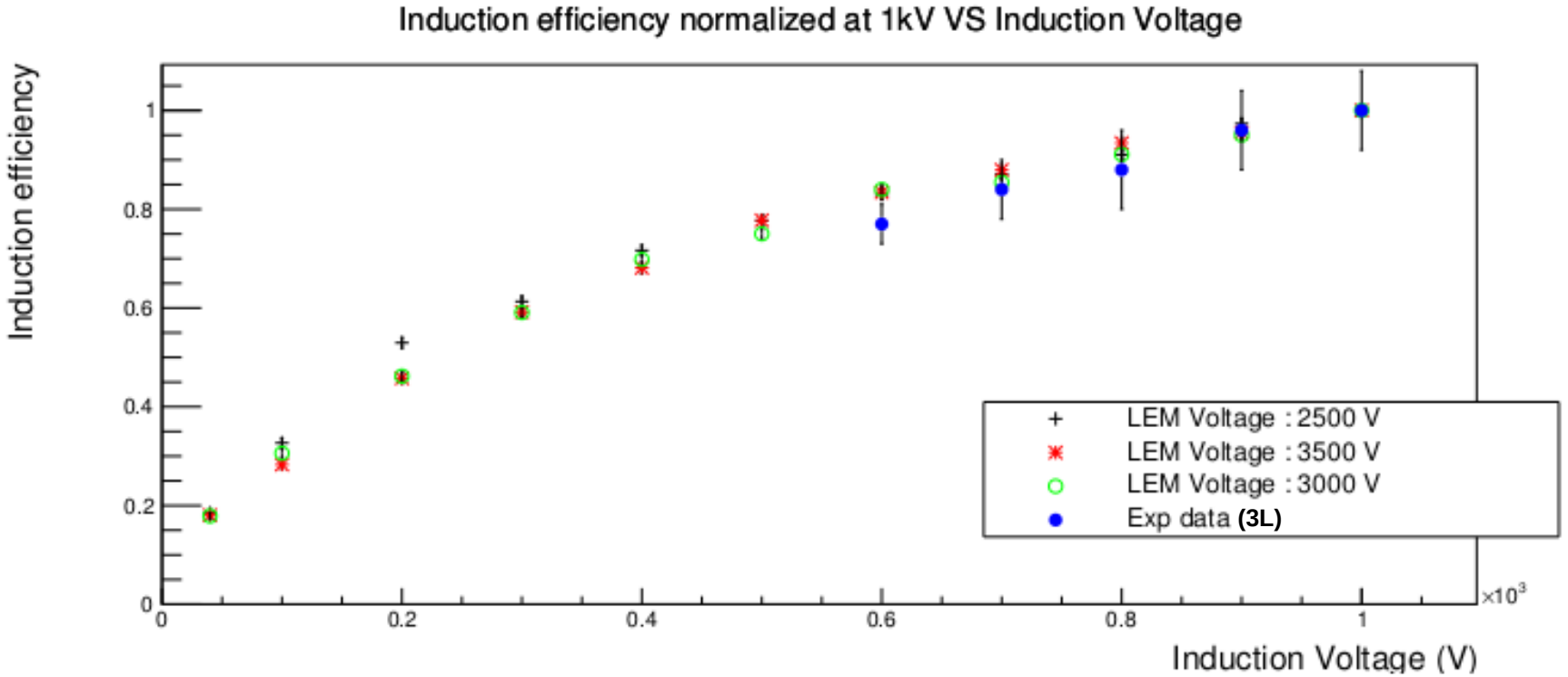
→ **We should be able to divide extraction voltage by 2 without loosing efficiency !**
Can it be checked in the 311 ?

Now it does : efficiency is a bit lower



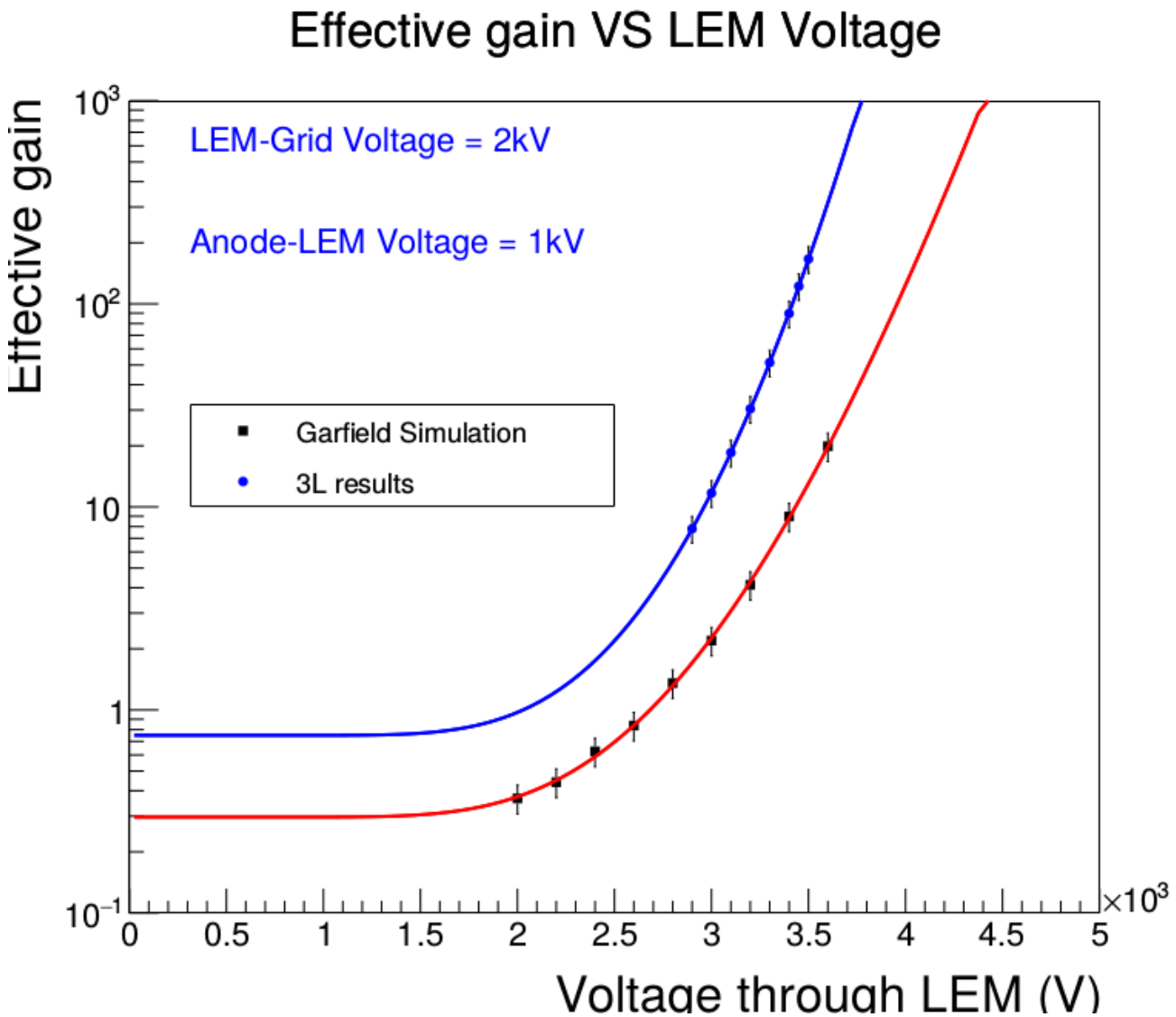
→ **Diminishing Grid-LEM voltage will significantly diminish efficiency.**


Induction efficiency VS Induction Voltage
Induction efficiency
Extr. Voltage = 2.5kV
Optimal voltage 1000V
Ind. Eff. = 0.7
Currently used voltage 200V
Extr. Eff. = 0.32
LEM Voltage : 2500 V
LEM Voltage : 3500 V
LEM Voltage : 3000 V
×10³
Induction Voltage (V)


Induction efficiency normalized at 1kV VS Induction Voltage
Induction efficiency
LEM Voltage : 2500 V
LEM Voltage : 3500 V
LEM Voltage : 3000 V
Exp data (3L)
×10³
Induction Voltage (V)

Effective gain : simulation of 3L and comparison to measurements

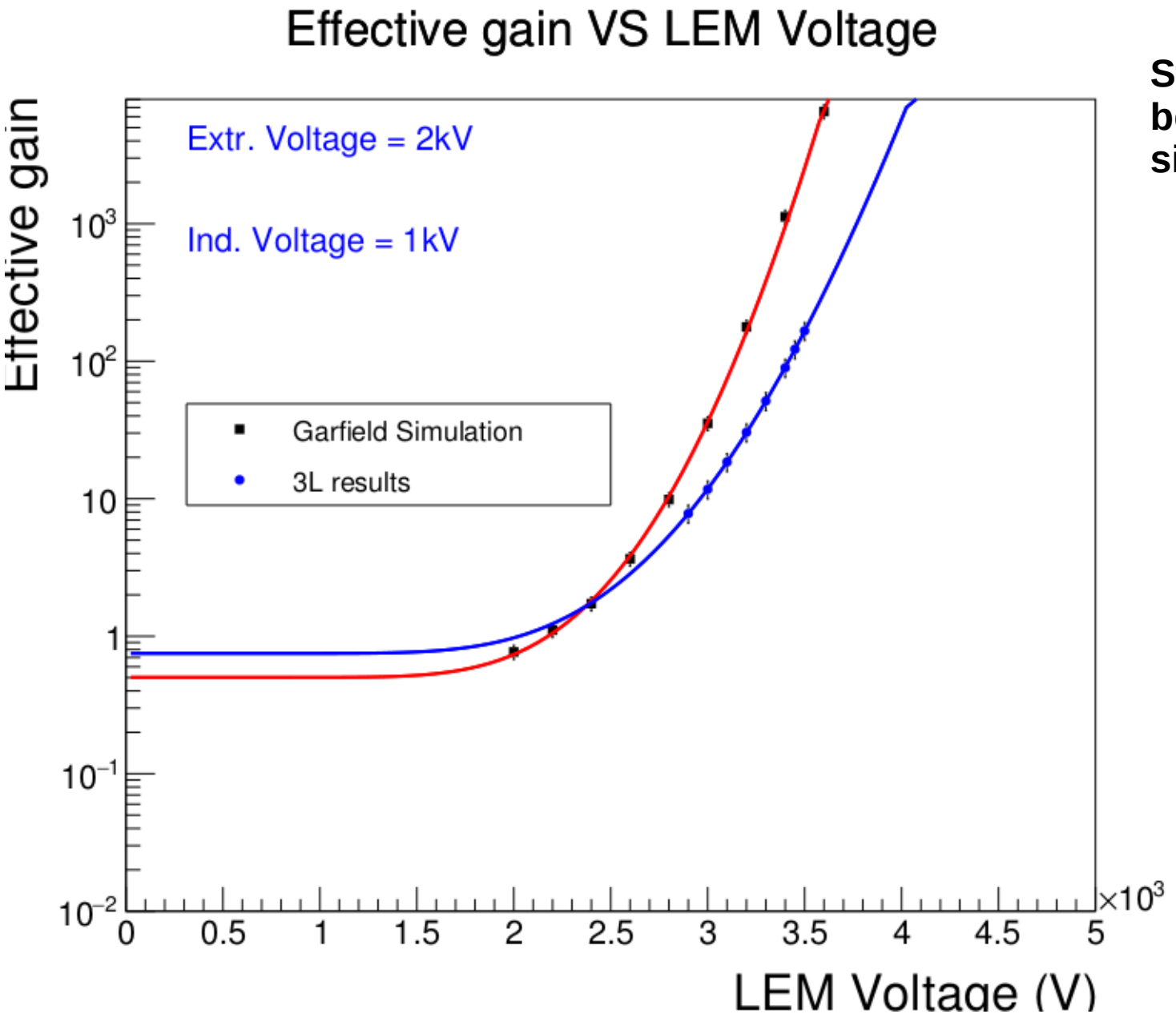
Pressure set to 735 Torr to match experimental conditions



Simulated gain ~ one third of measured gain
=> Measurement were done before charging up : should be equal to simulation

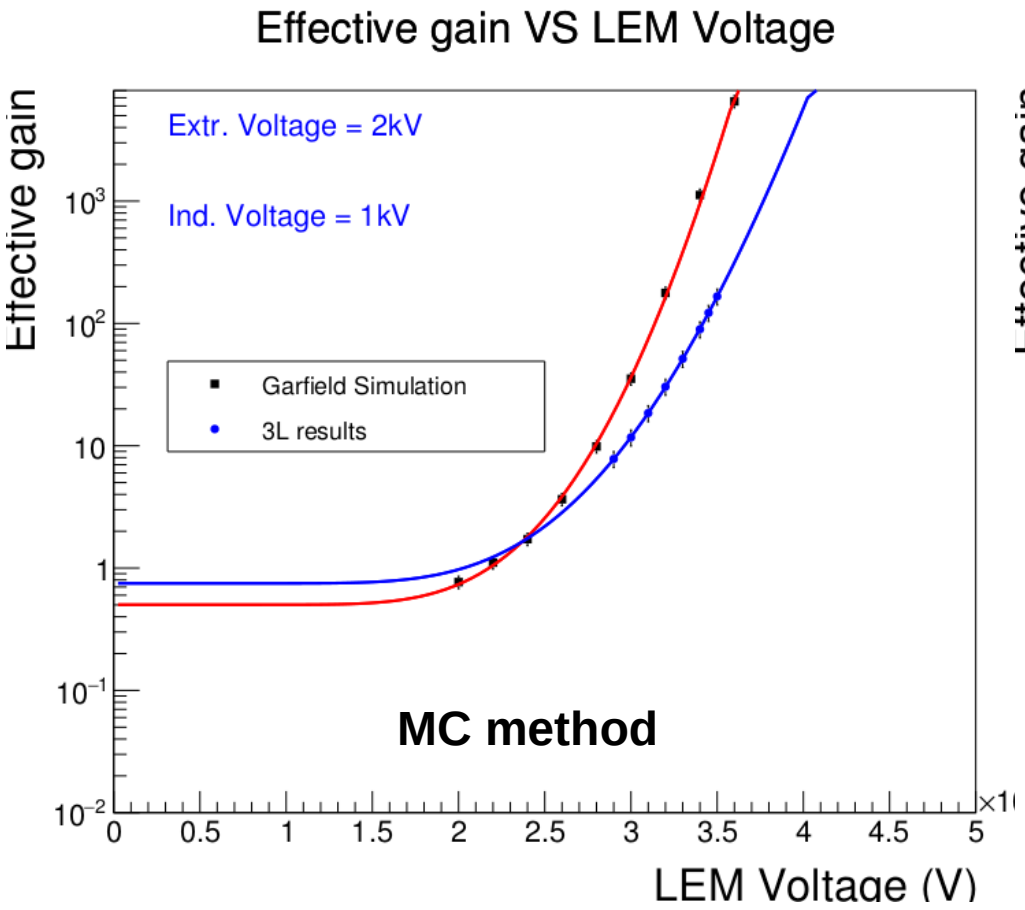
Possible explanations :
- GarField microscopic tracking not reliable for avalanche?
→ try other simulation methods (next slide)
- Should consider possible photoelectric effects of UV going back to hit the grid, producing more electrons, increasing gain?
→ in progress

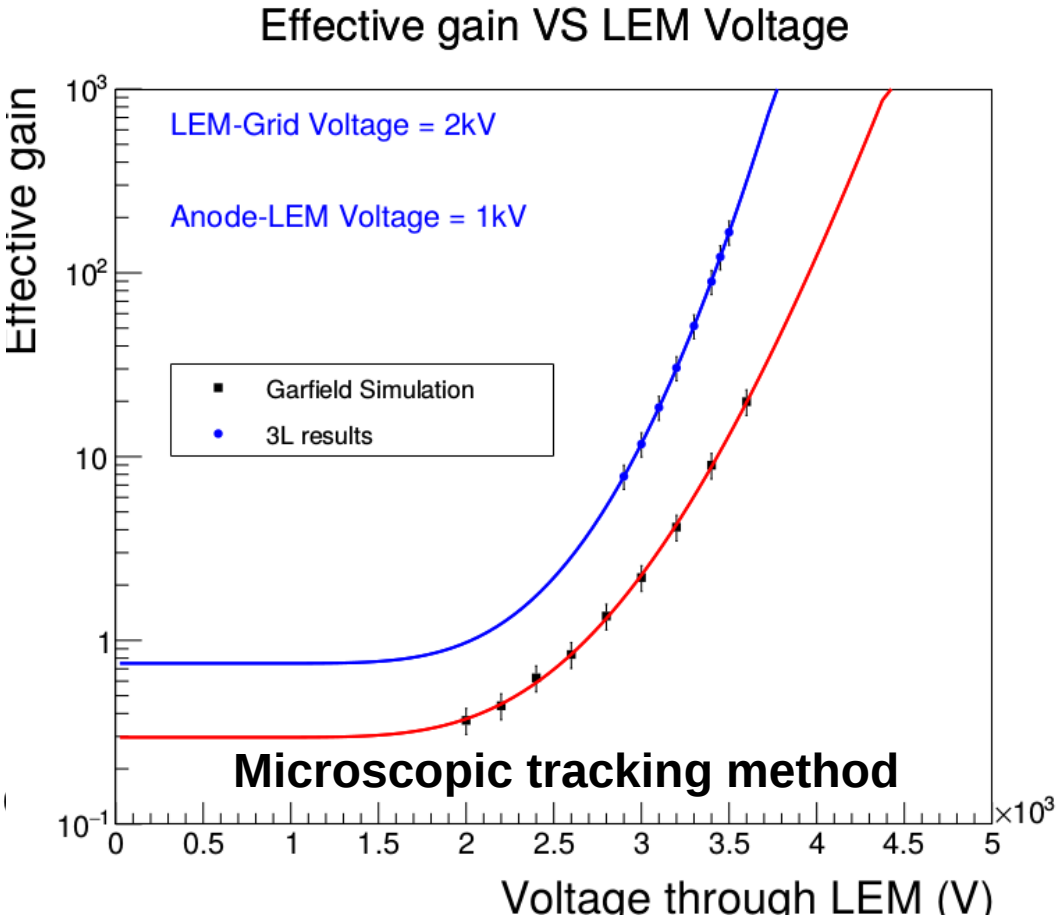
3L simulation with Garfield's MC method



Still a big discrepancy between data and simulation

3L simulation with Garfield's MC method



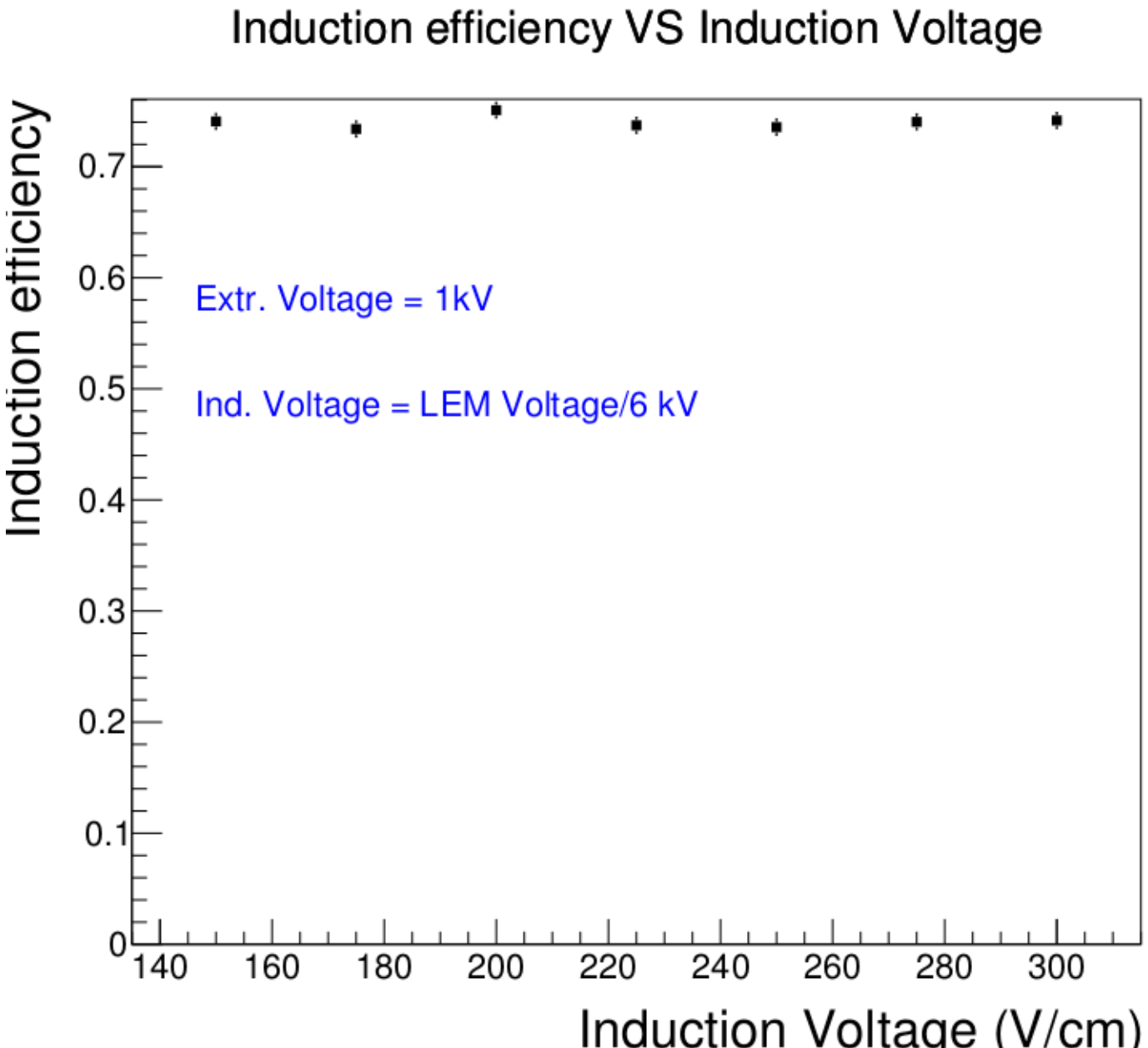


None of the two methods fit the data.

Conclusion

- Extraction and induction efficiencies simulated, can be added to simulation and reconstruction software
- Could check the total extraction zone efficiency at lower extraction voltage on the 311
- Simulated gain is not coherent with measurements, needs more investigations

Induction efficiency when keeping the ratio of voltages induction/amplification constant



Simulation of Saclay's HP Chamber when amplification voltage = 6 x induction voltage : Efficiency is constant