# FTM Simulations

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Outline

1. Setup and simulations

2. Gain

3. Time resolution

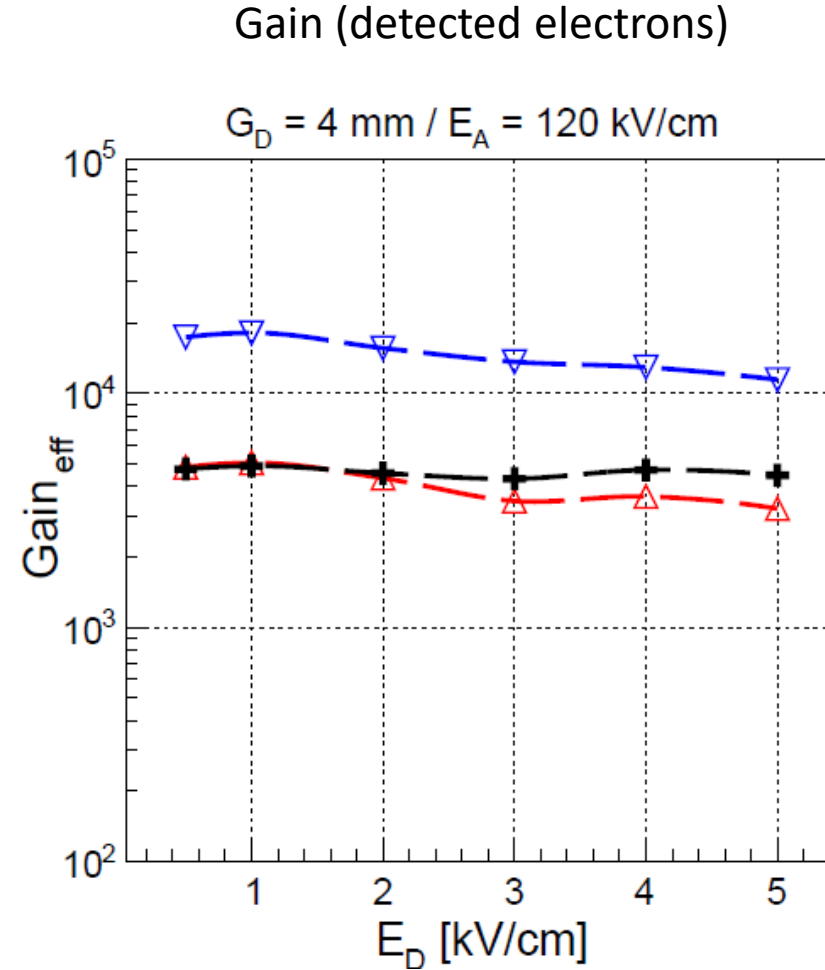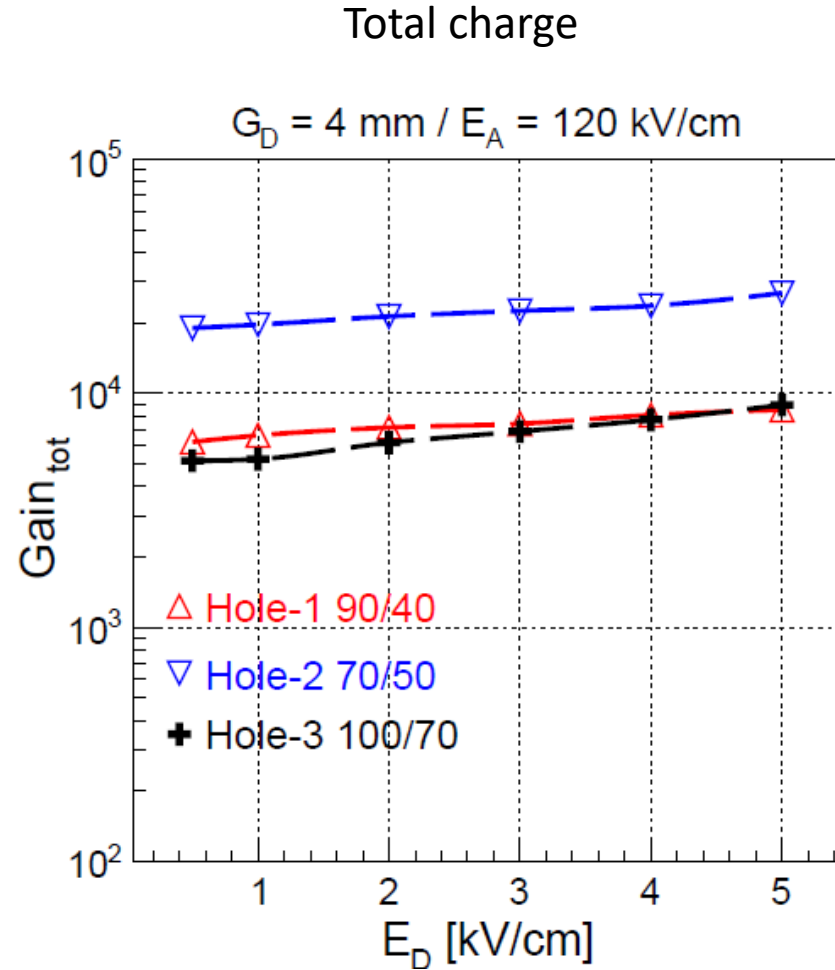4. Efficiency

5. Challenges and future work

1- Setup and simulations

- Field map with ANSYS

- Garfield++ simulations with HEED: 50 GeV/c muons coming downward in Ar/CO_2:70/30.

- 2000 simulated events for each configuration.

- Time resolution determined by the time of the fastest drifting primary ionization electrons.

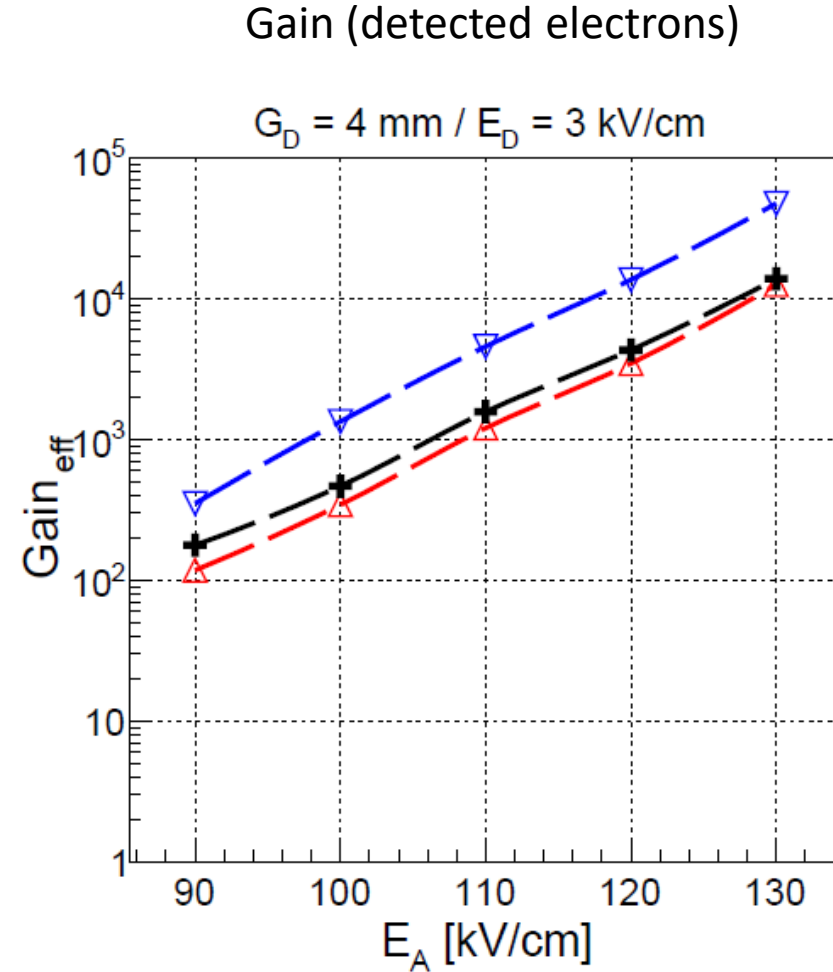- Tested different hole diameters as proposed in successive prototypes
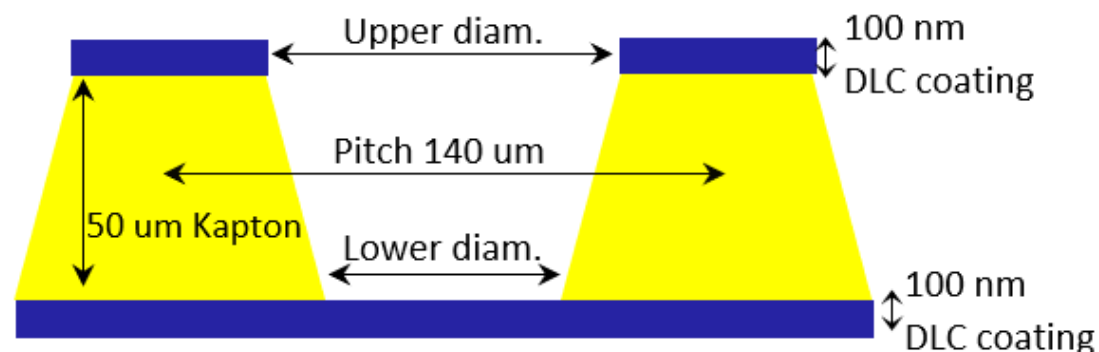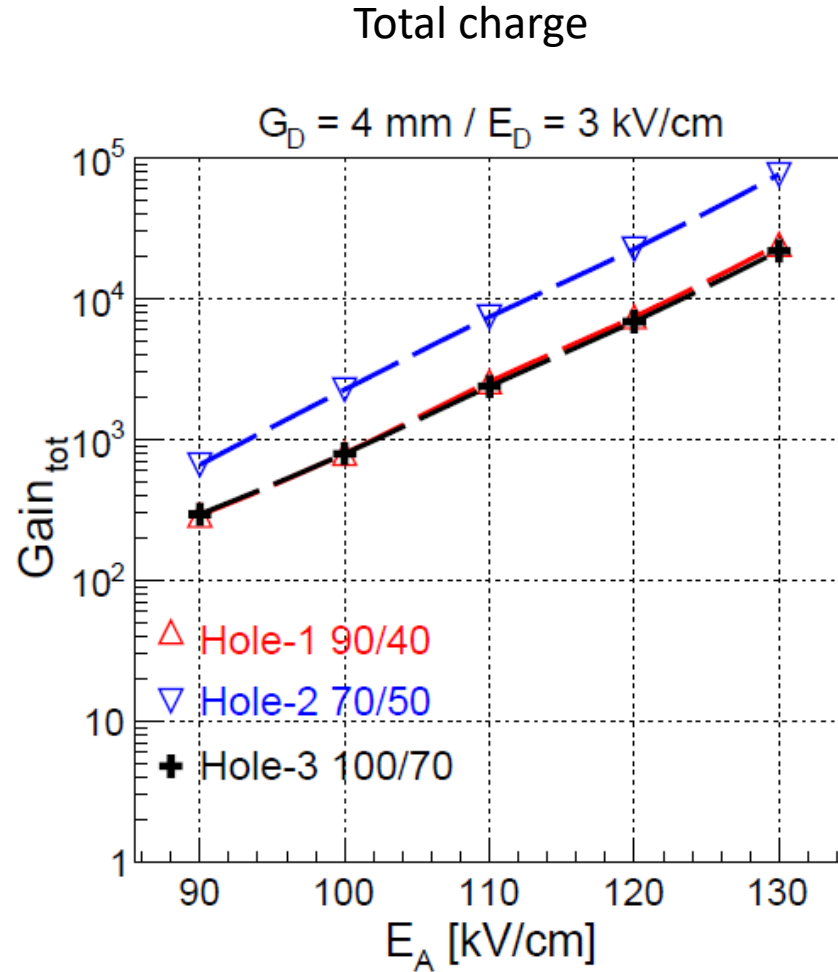

Config. name	Hole-1	Hole-2	Hole-3
Upper diameter (μm)	90	70	100
Lower diameter (μm)	40	50	70

2- Gain vs. drift field

Total charge

Gain (detected electrons)

2- Gain vs. amplification field

Total charge

$G_D = 4$ mm / $E_D = 3$ kV/cm

$\triangle$ Hole-1 90/40
$\triangledown$ Hole-2 70/50
+ Hole-3 100/70

Gain (detected electrons)

$G_D = 4$ mm / $E_D = 3$ kV/cm

3- Time resolution

Time resolution vs. drift field

G_D = 4 mm / E_A = 120 kV/cm

△ Hole-1 90/40
▽ Hole-2 70/50
+ Hole-3 100/70

τ [ns]

E_D [kV/cm]
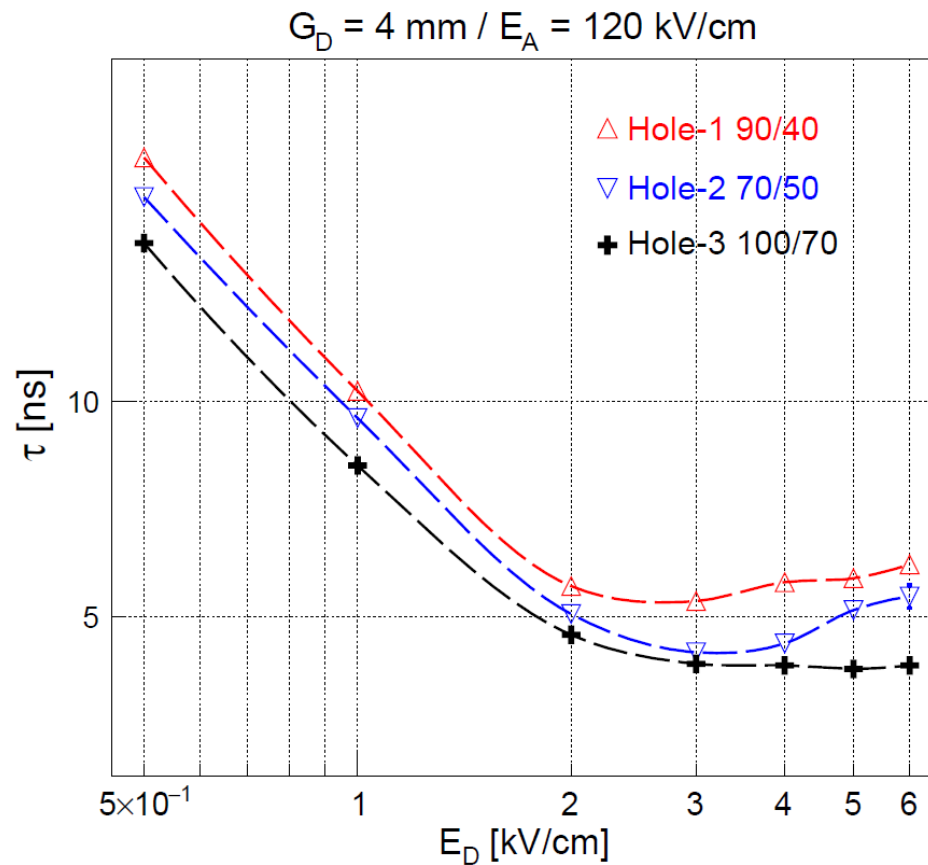
Time resolution vs. Number of layers

E_D = 120 kV/cm / E_A = 120 kV/cm

△ Hole-1 90/40
▽ Hole-2 70/50
+ Hole-3 100/70

τ [ns]

FTM Layers

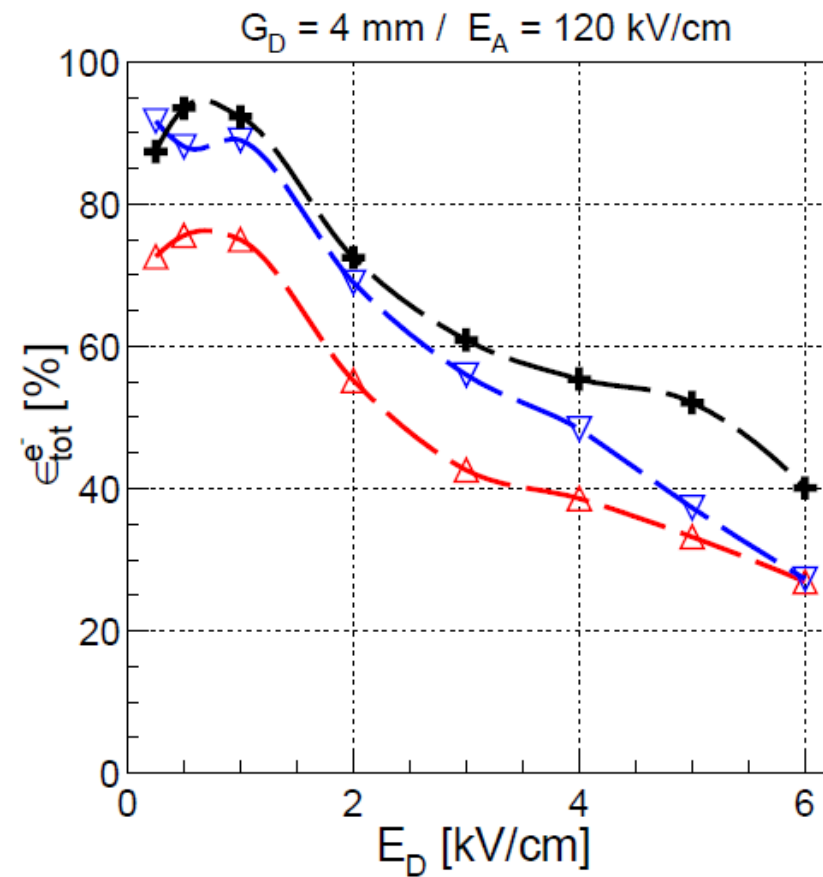**Deviation from linear behavior**
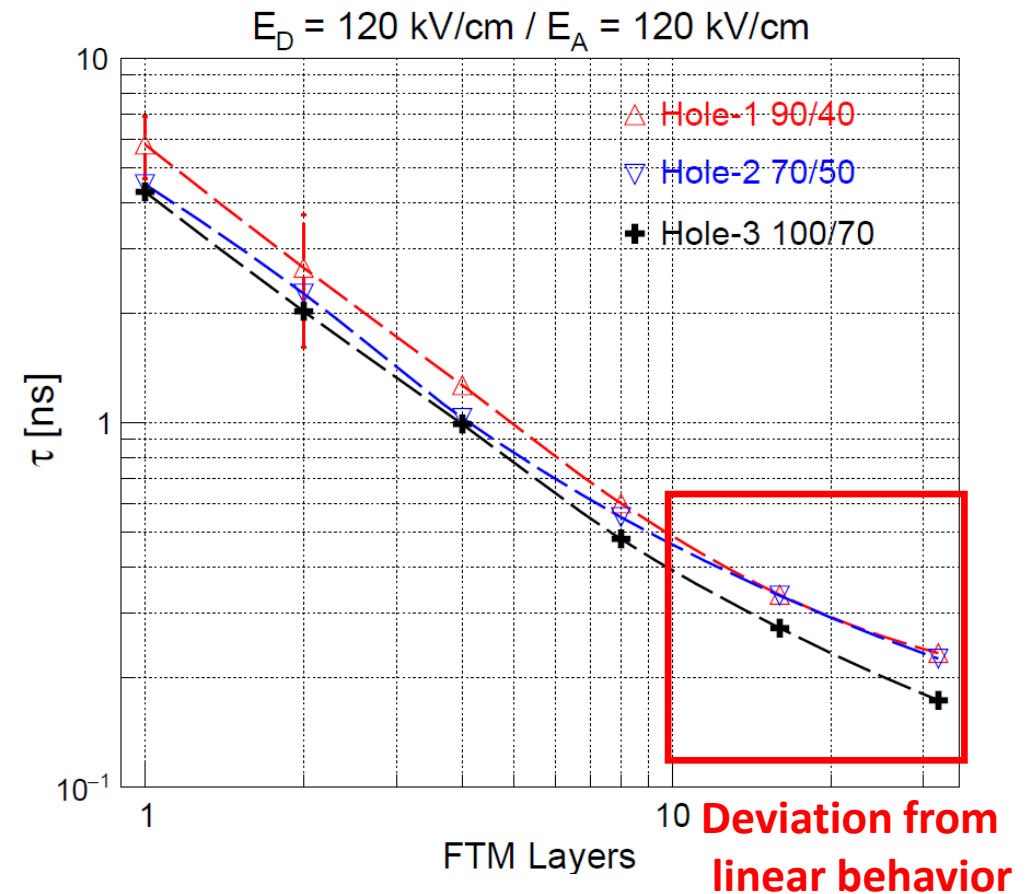
4- Efficiency vs. drift field

Collection efficiency = $\dfrac{\text{electrons entering the hole}}{\text{total simulated electrons}}$
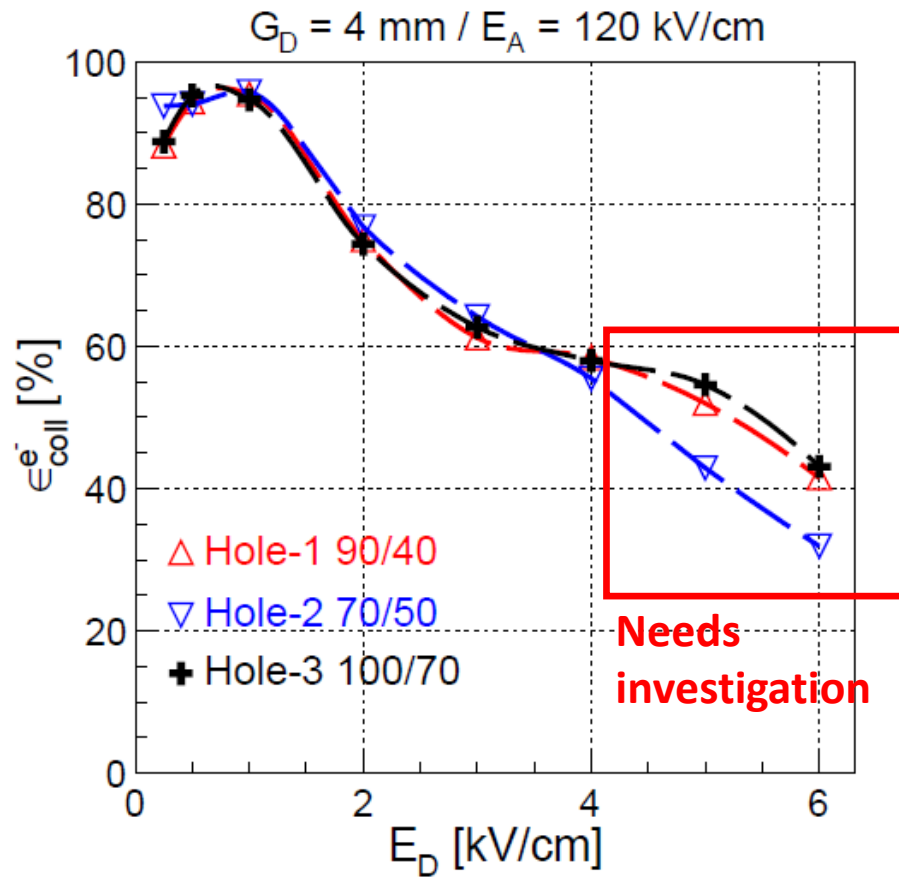
Detection efficiency = $\dfrac{\text{electrons reaching readout}}{\text{total simulated electrons}}$

G_D = 4 mm / E_A = 120 kV/cm

△ Hole-1 90/40
▽ Hole-2 70/50
✛ Hole-3 100/70

Needs investigation

4- Efficiency vs. amplification field

Collection efficiency = $\dfrac{\text{electrons entering the hole}}{\text{total simulated electrons}}$

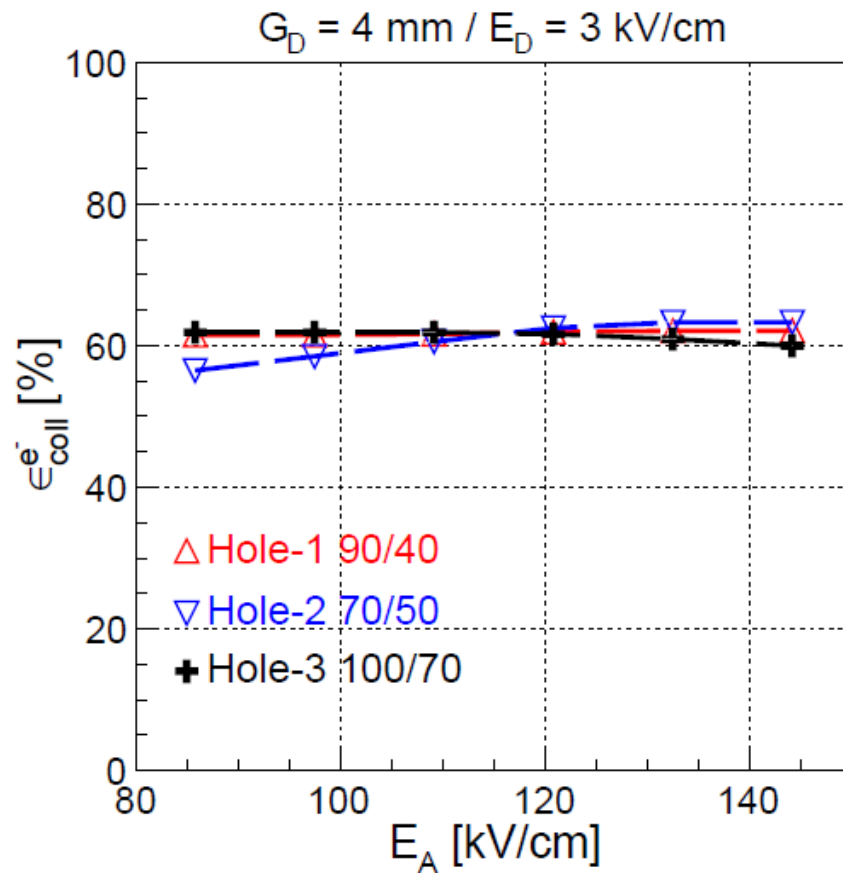Detection efficiency = $\dfrac{\text{electrons reaching readout}}{\text{total simulated electrons}}$

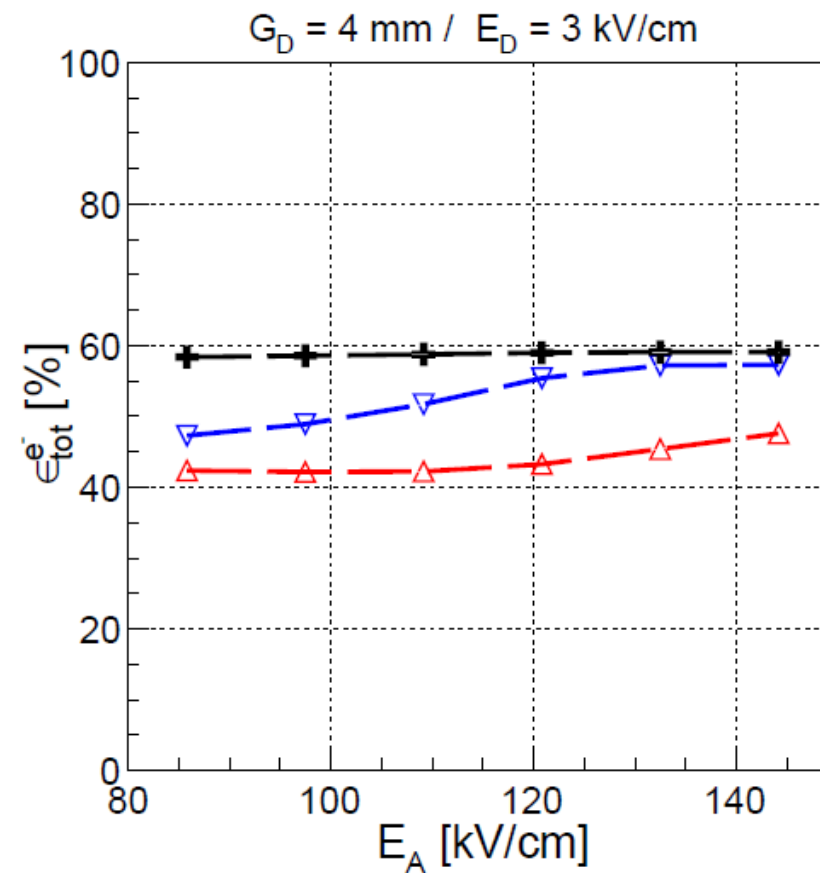# 4- Global detector efficiency

- Collection efficiency of primary ionization electrons produced by the passage of a 50 GeV/c muons in Ar/CO_2:70/30, as a function of the FTM gap size.

- Compared with theoretical maximum expected from the Poisson distribution (3.3 cls/mm).

- The decrease in efficiency at smaller gaps can explain the deviation in time resolution

E_D = 3 kV/cm / E_A = 120 kV/cm

Hole-1 90/40
Hole-2 70/50
Hole-3 100/70
Theory
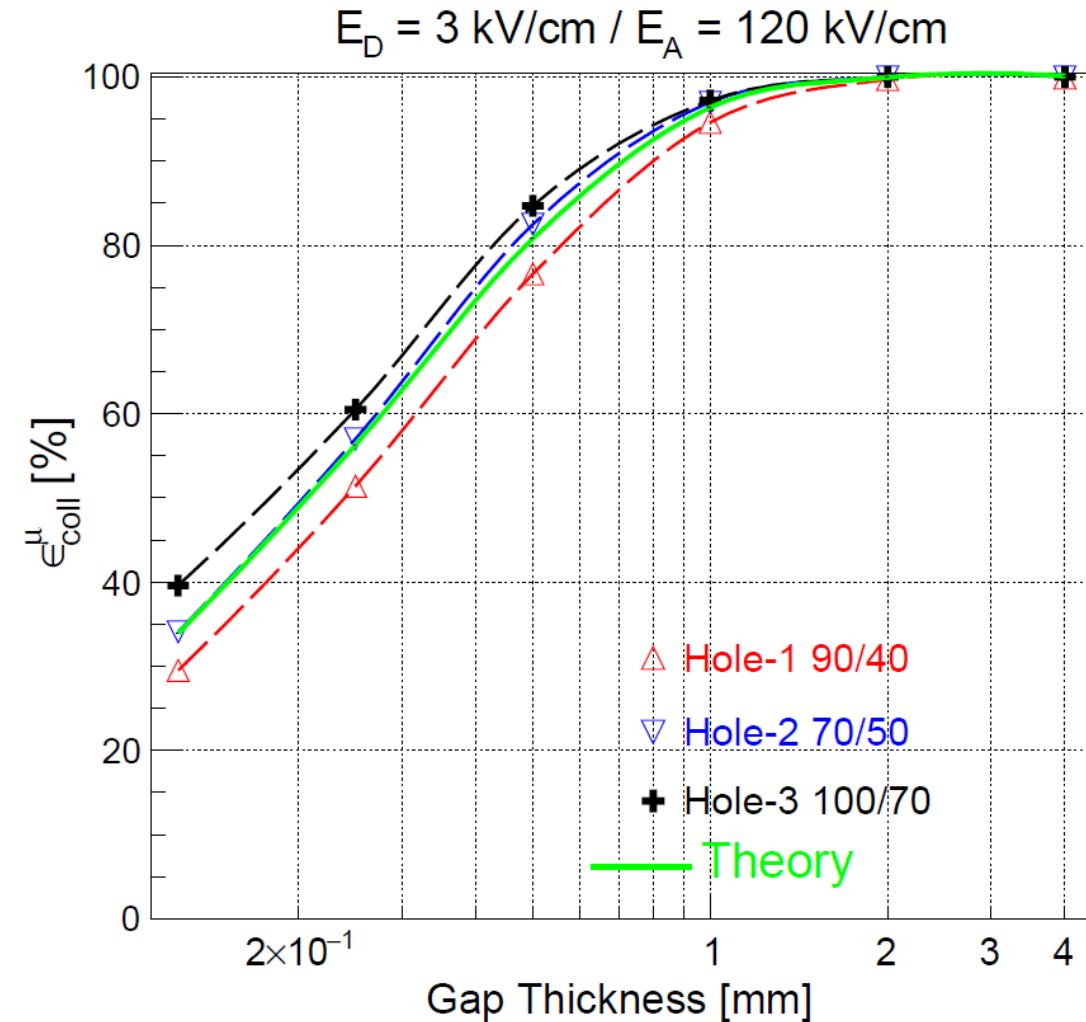
5- Challenges and future work

❖ Understand efficiency and investigate effects related to hole diameters:

➢ It seems both top and bottom diameters affect the efficiency

➢ The top diameter impacts on the way electron drift on the hole

➢ Does the bottom diameter affect the electric field inside the hole?

➢ Extract field intensity from the field map and compare it for different hole diameters

❖ Make new simulations with updated geometry