FTM detector for fast timing applications

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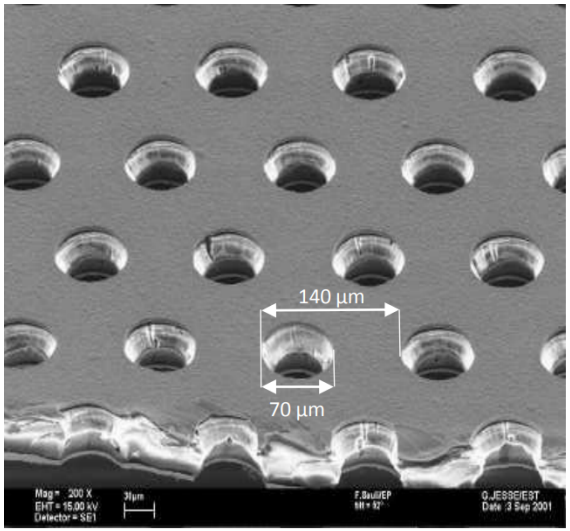
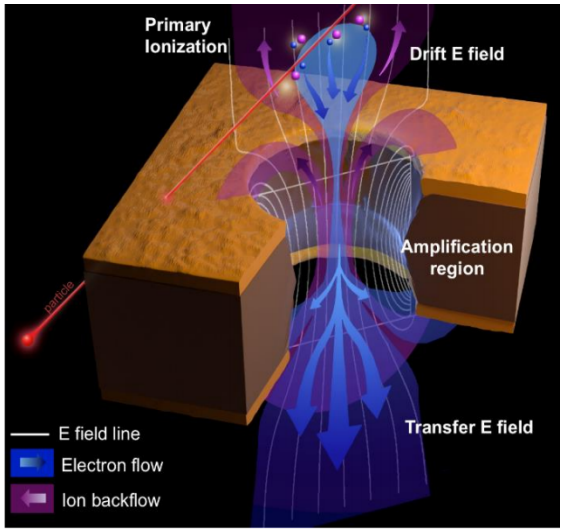
MPGD: Micro-Pattern Gaseous Detector

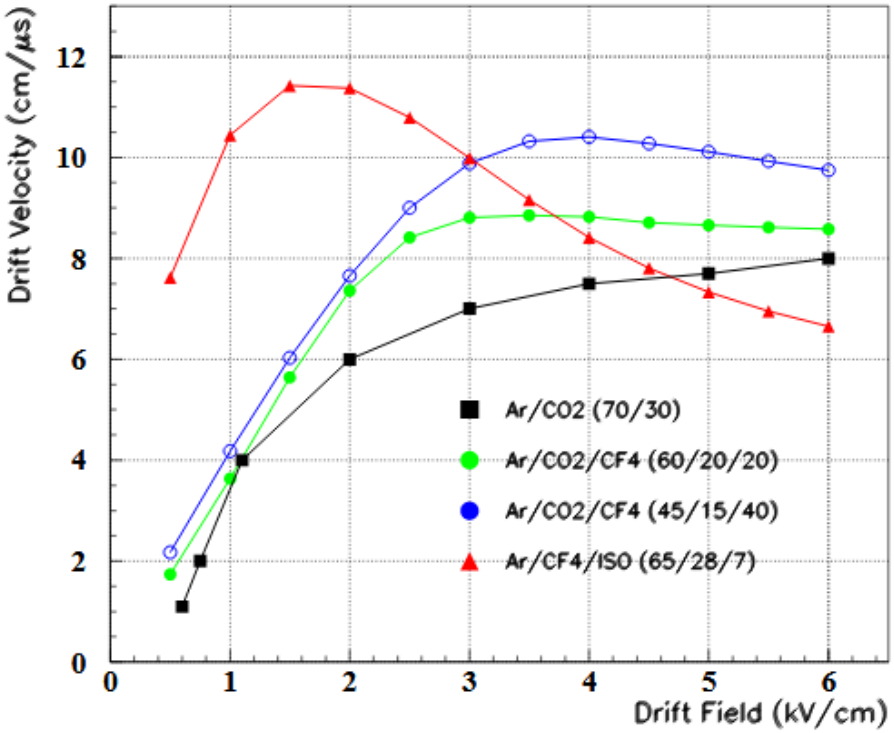


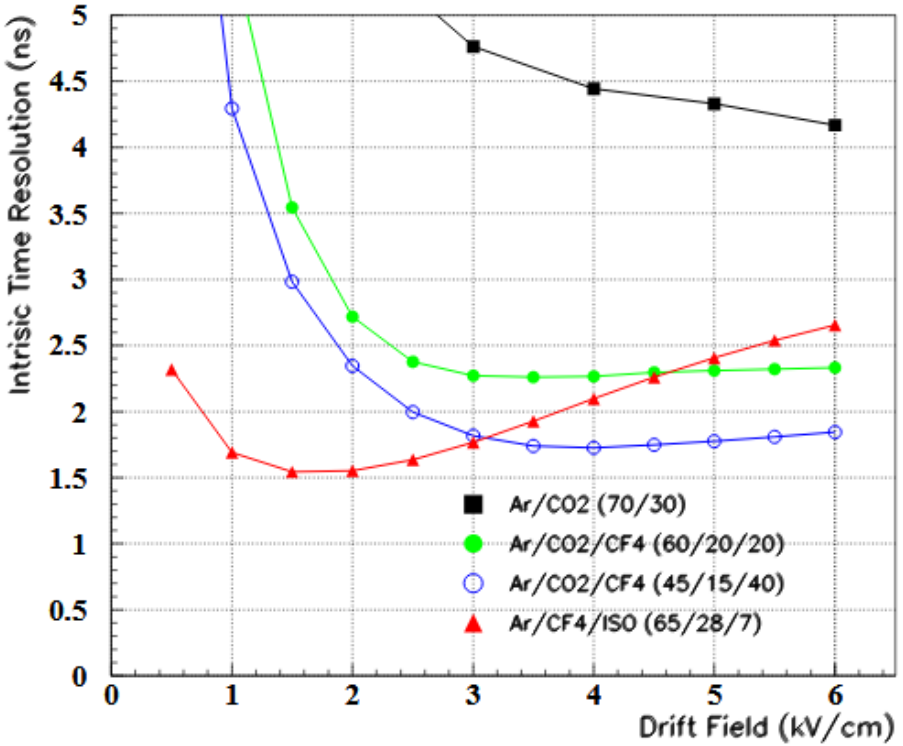


- High rate capability
- Good spatial resolution
- Flexibile geometry, large areas covrage
- Gain limitation: $\sim 10^3$ for a single stage (GEM)
- Time resolution of few ns, not sufficent for fast time applications, such as triggering at high luminosity and medical applications.

Drift velocity and time resolution (GEM)

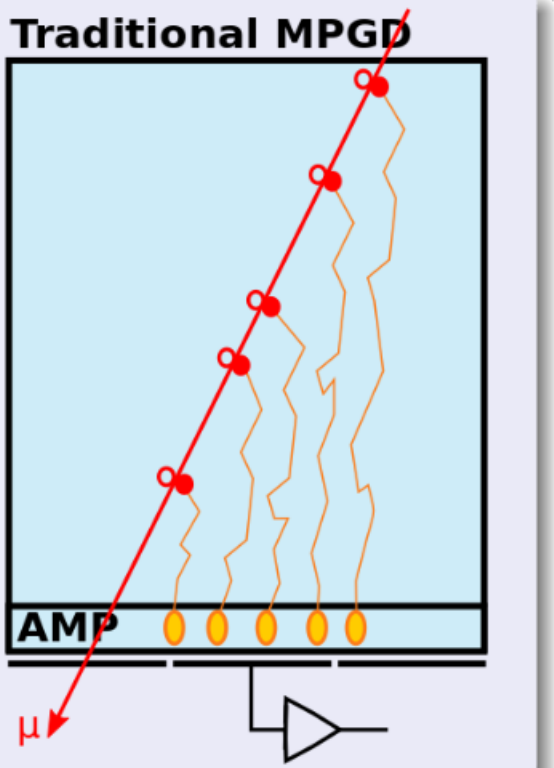
https://cds.cern.ch/record/940631/files/thesis-2006-013.pdf





Gas Mixture	Drift velocity (drift field)	< Clusters/mm >	Intrinsic time resolution
Ar/CO_2 (70/30)	7 cm/μs (@3 kV/cm)	3.3	4.7 ns (@3 kV/cm)
$Ar/CO_2/CF_4$ (60/20/20)	9 cm/μs (@3 kV/cm)	5	2.3 ns (@3 kV/cm)
$Ar/CO_2/CF_4$ (45/15/40)	10.5cm/μs (@3.5 kV/cm)	5.5	1.7 ns (@3.5 kV/cm)
$Ar/CF_4/iso\text{-}C_4H_{10}$ (65/28/7)	11.5 cm/μs (@2kV/cm)	5.7	1.5 ns (@2 kV/cm)

Fast timing MPGD (FTM)



σ_t driven by distance fluct's

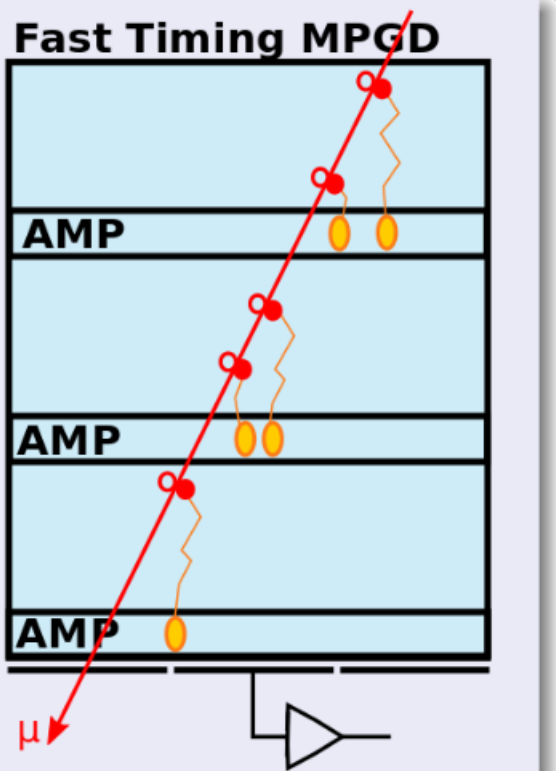
$$\sigma_t \propto 1/(\lambda v_{\text{drift}})$$

$\lambda = \#$ primary cls

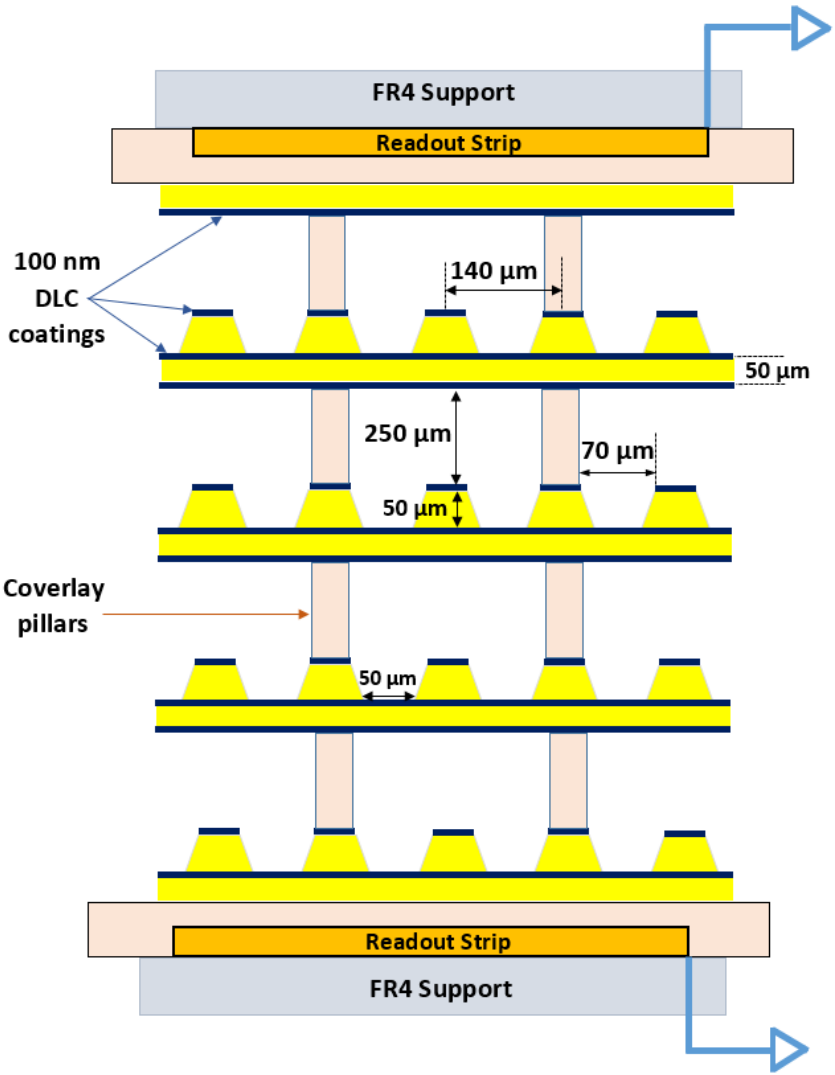
electron-ion pairs created close to amplification structure result in fast signals

Fast Timing MPGD: split drift volume in N layers, each with own amplification structure

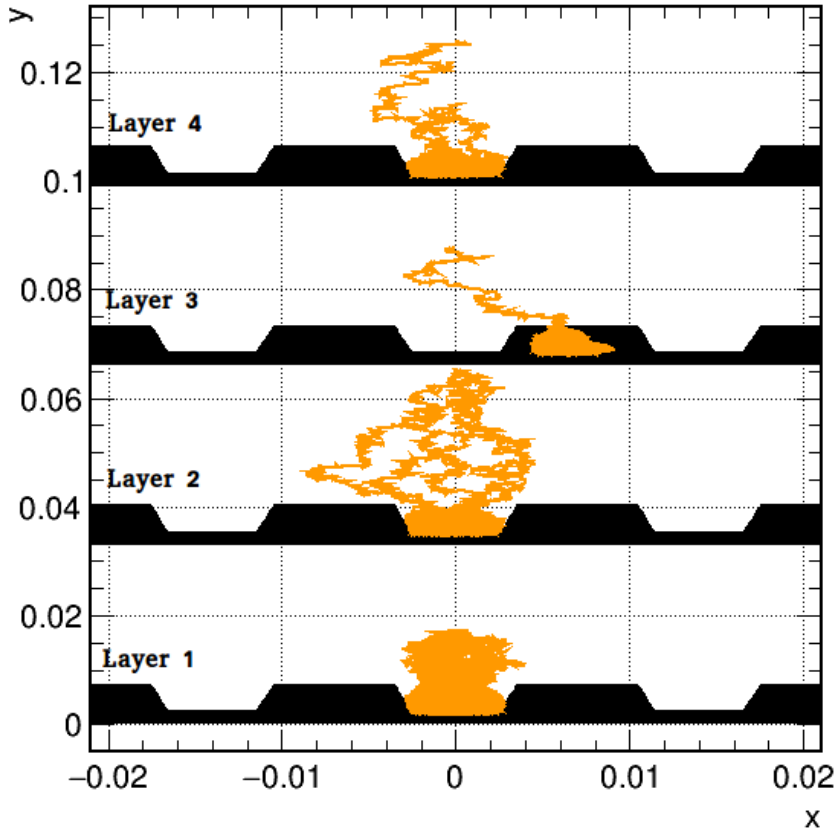
$$\sigma_t \propto 1/(\lambda v_{\text{drift}} N)$$



FTM Detector layout



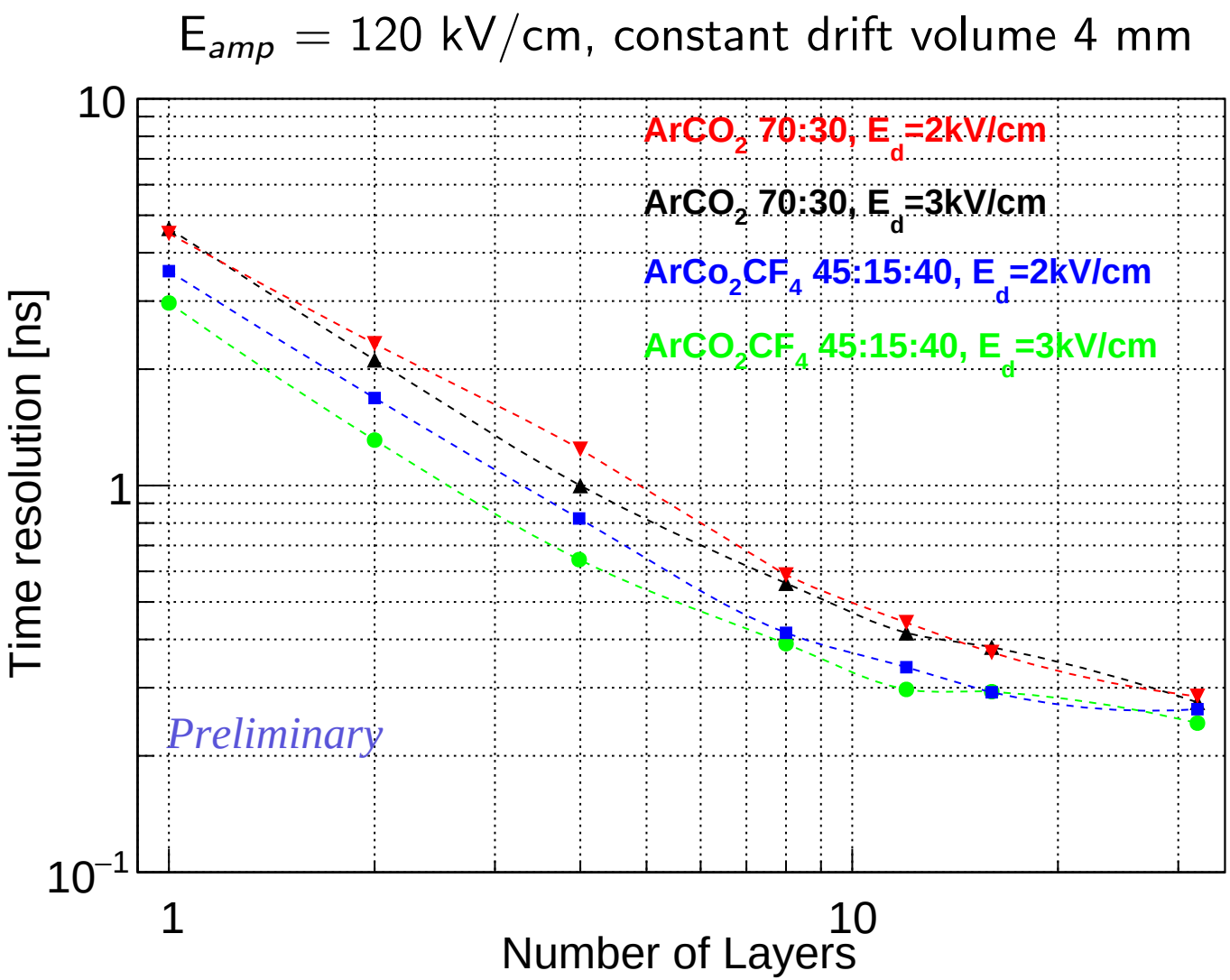
- European Patent Application 14200153.6
M. Maggi, A. Sharma, R. De Oliveira.
- Simulations with ANSYS (fields) and (Garfield++ detector and charge transport)



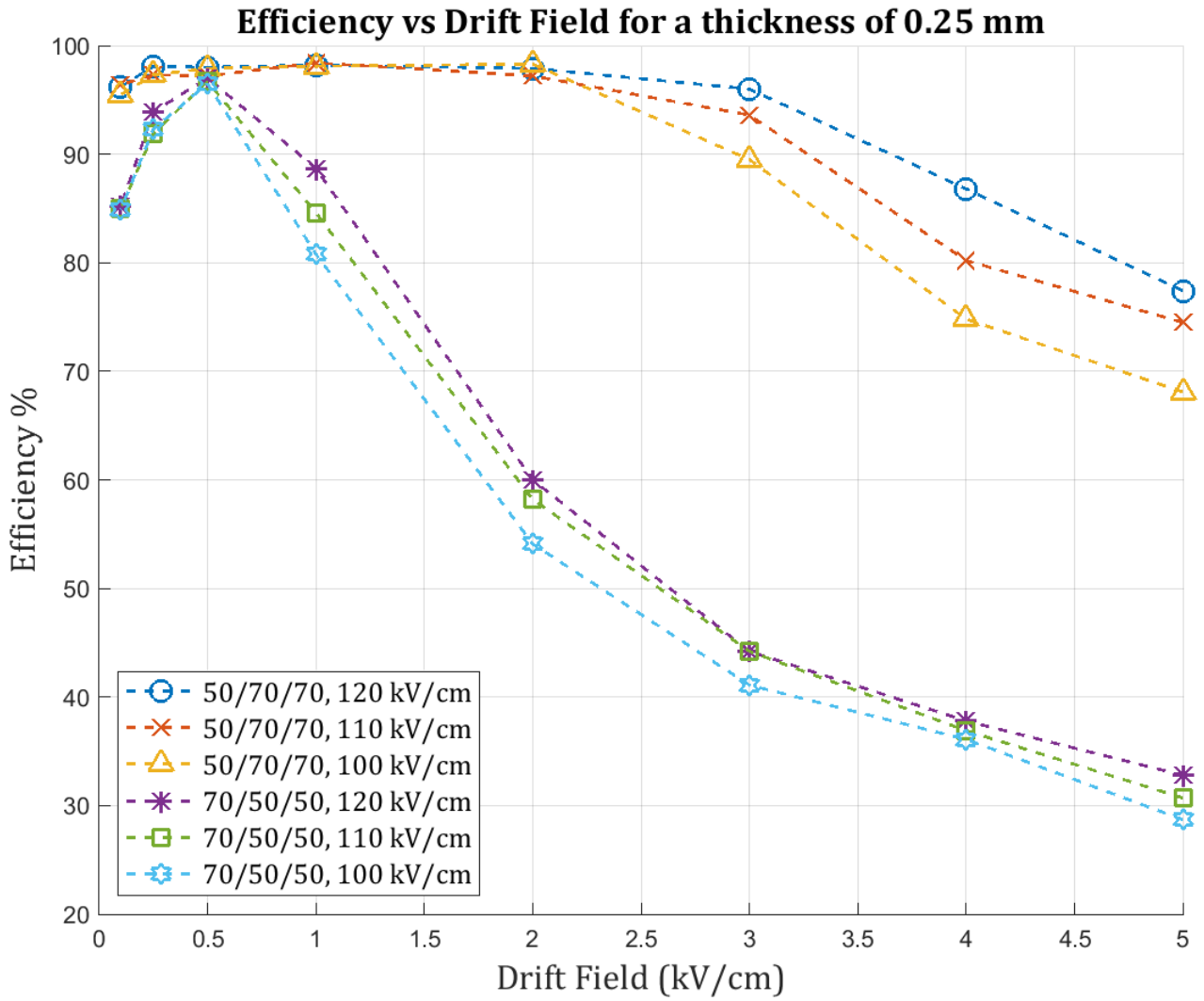
Parameters

- Drift field
- Amplification field
- Gas mixture
- Hole geometry
- Gap thickness
- Number of layers
- Electron threshold
- etc.

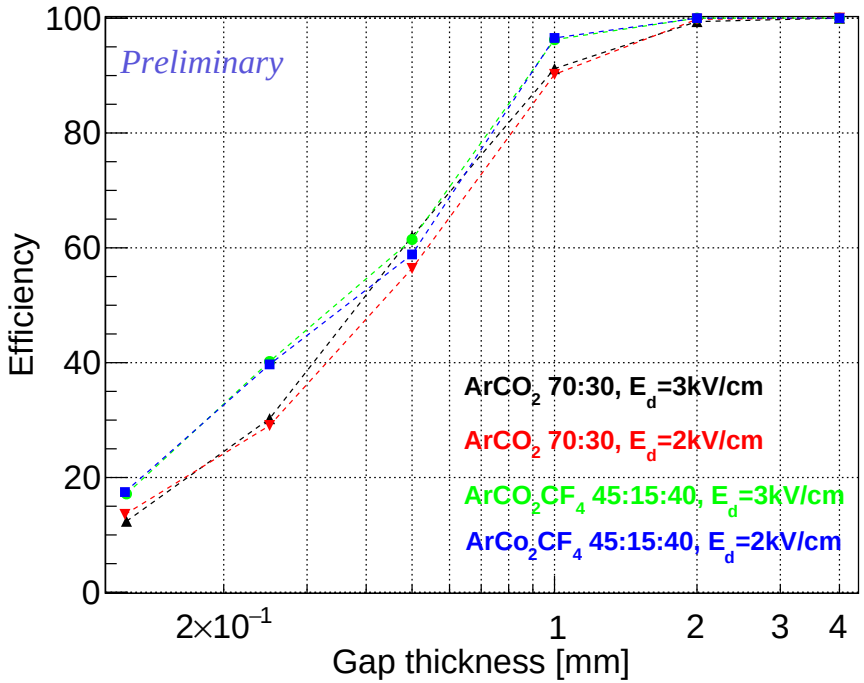
Time resolution

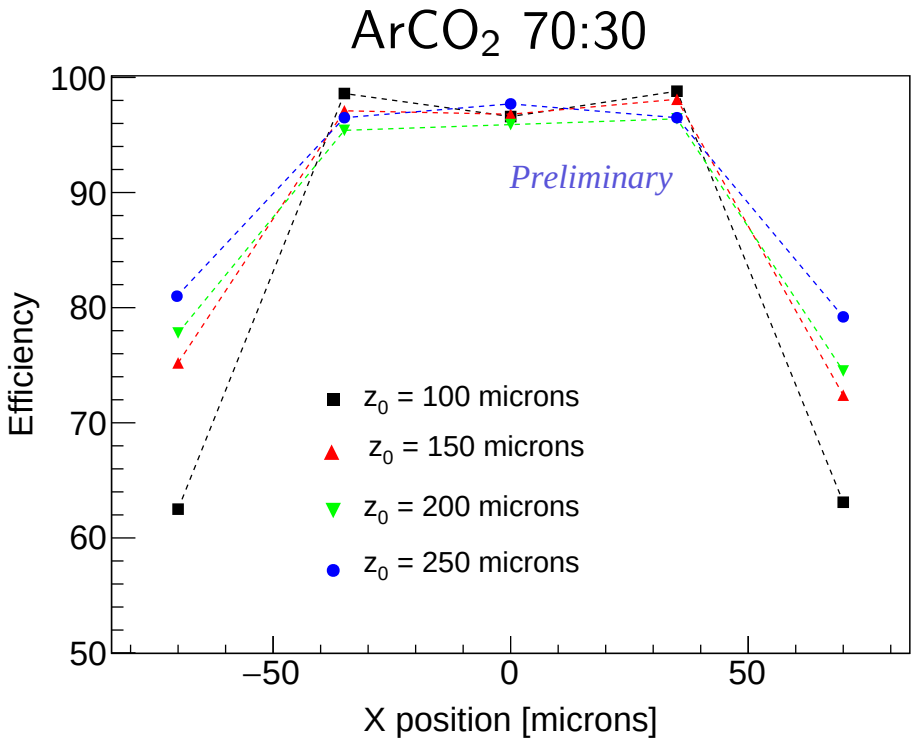


Fields and hole geometry



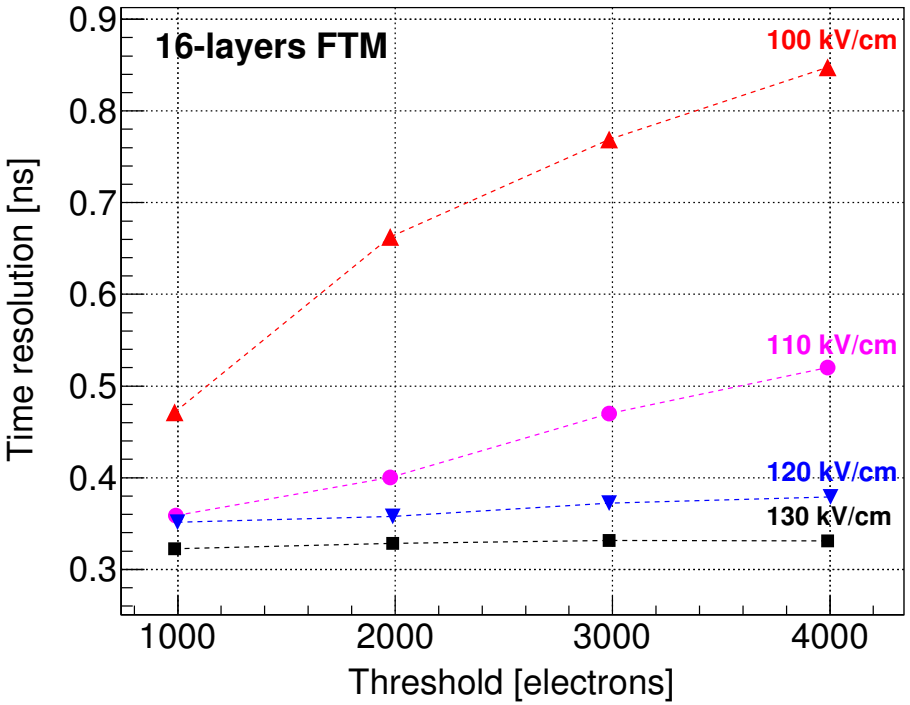
Gap thickness / vertical position

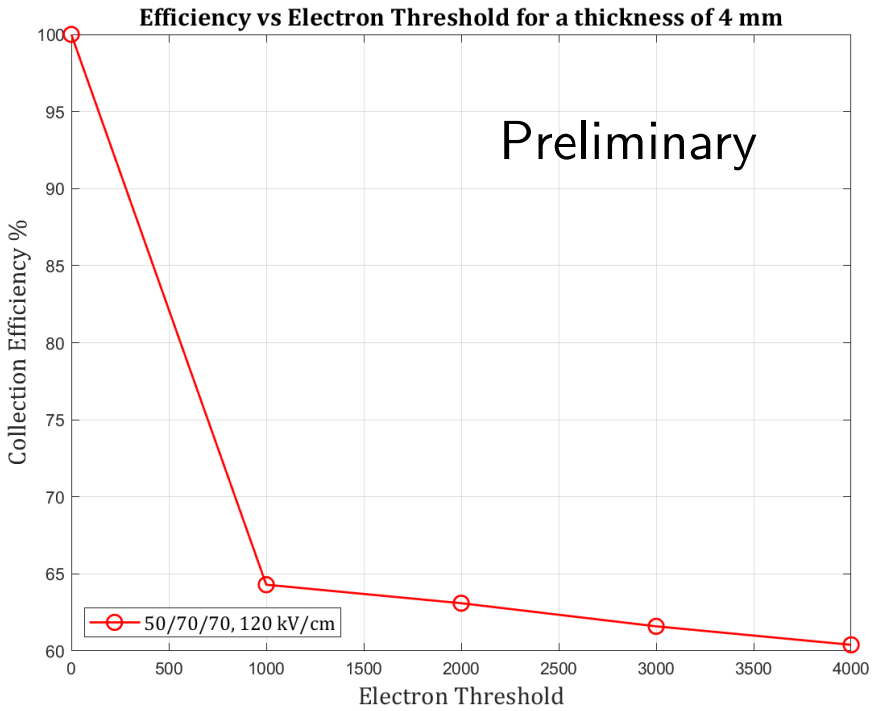




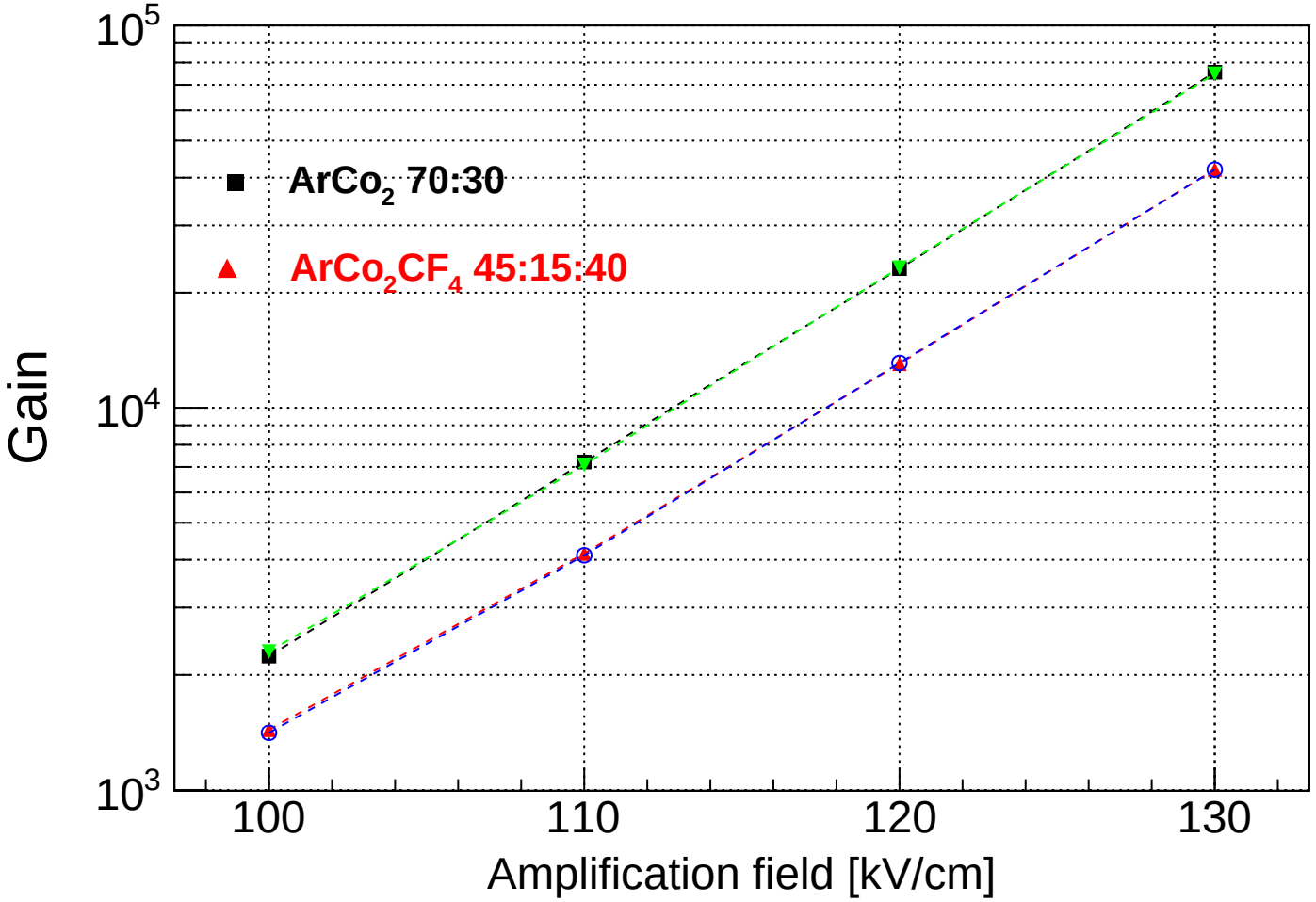
Electron avalanche threshold

E_d = 3 kV/cm, total drift volume 4 mm (16 x 250 microns)

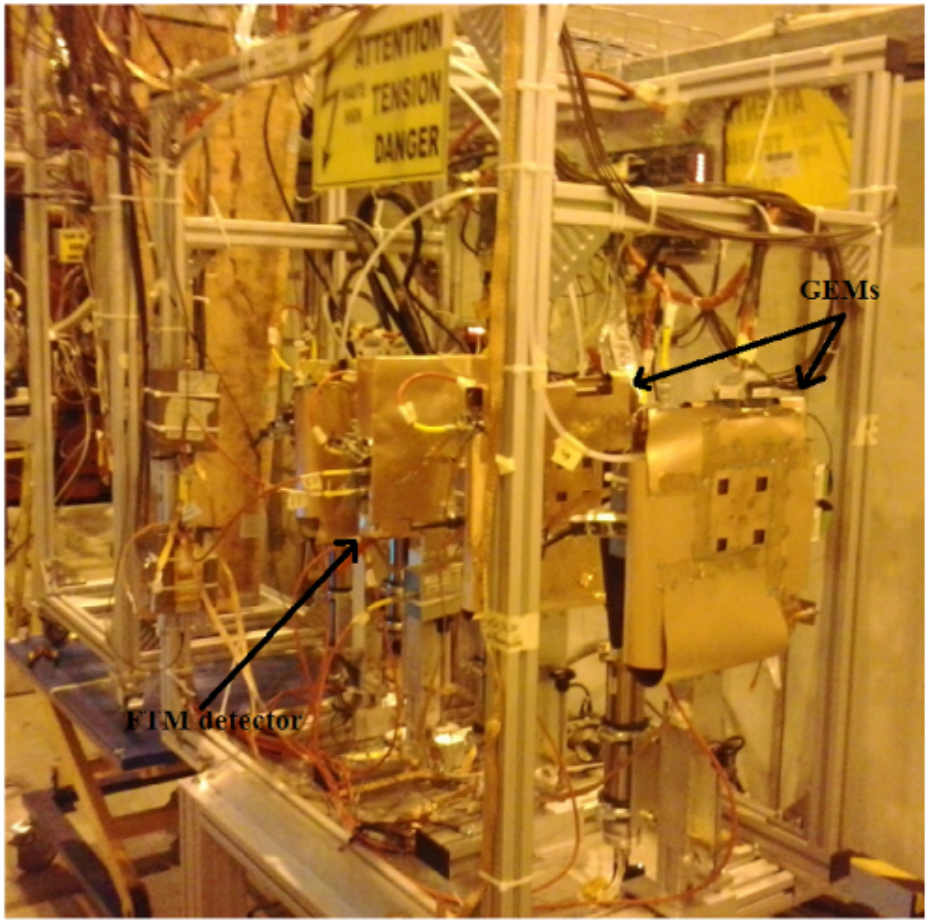




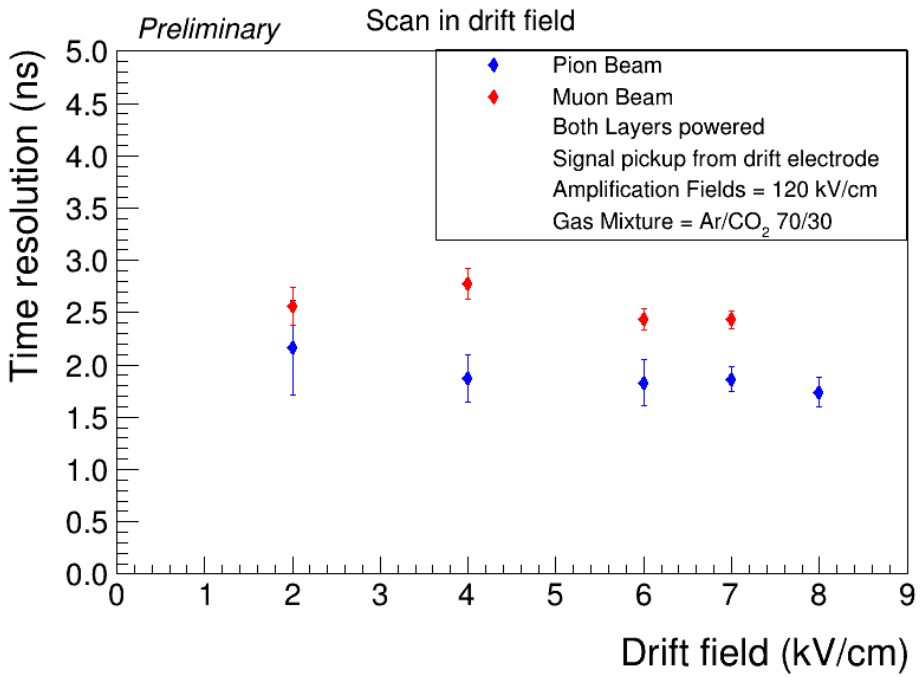
Gain


10^5
10^4
10^3
Gain
$ArCo_2$ 70:30
$ArCo_2CF_4$ 45:15:40
100
110
120
130
Amplification field [kV/cm]

2 layers FTM



Tests performed at SPS-CERN
Nucl. Instr. Meth.A 845 (2017),313



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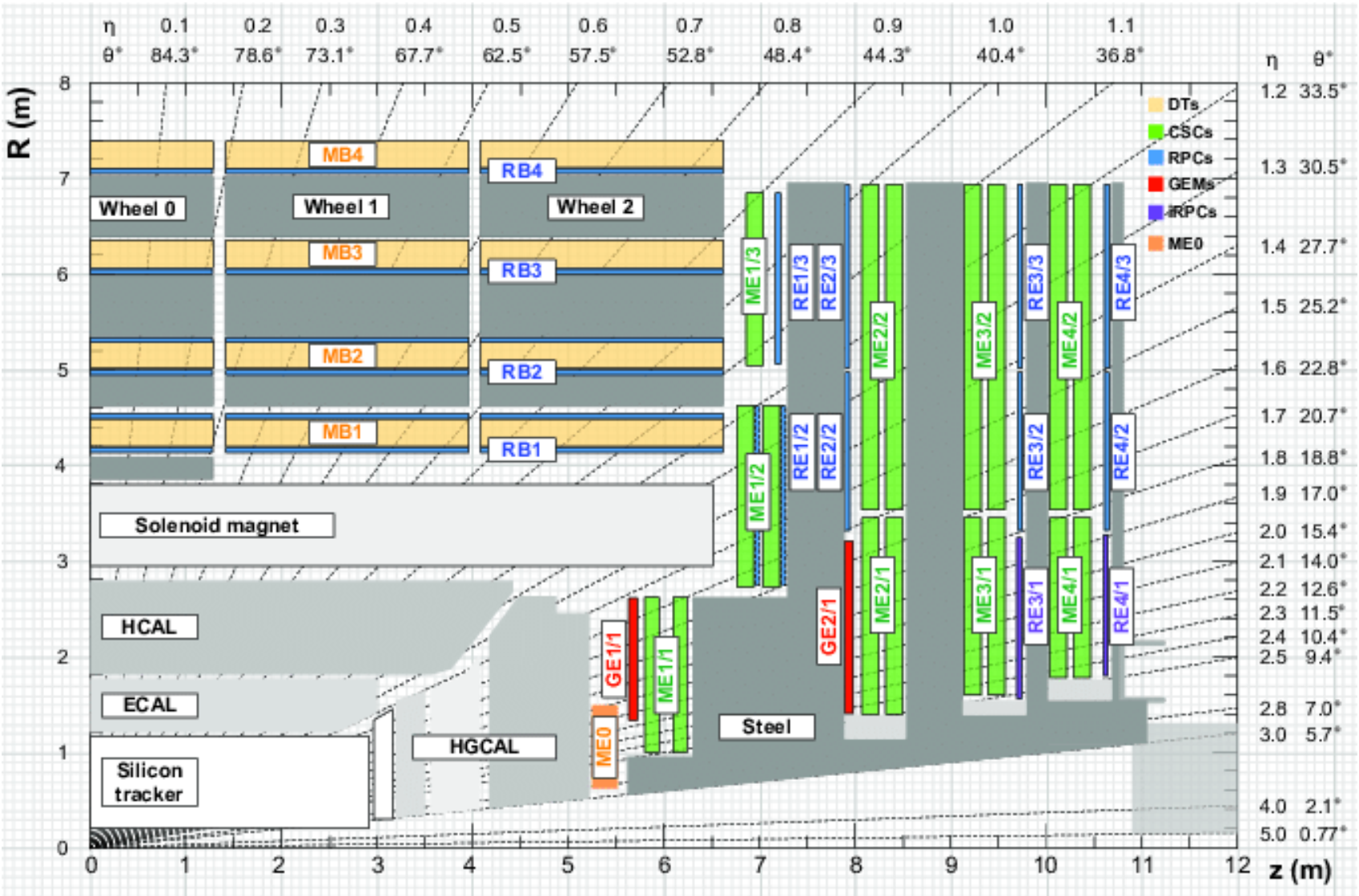
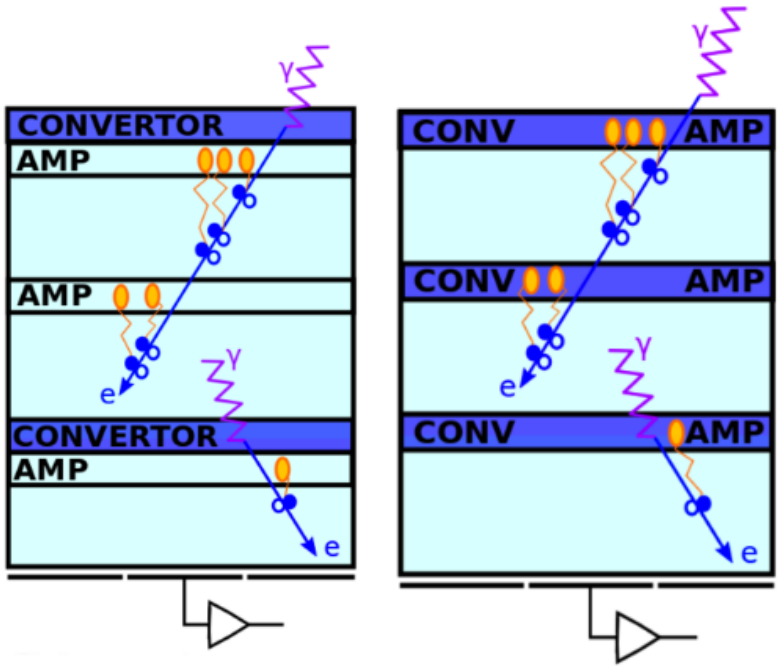
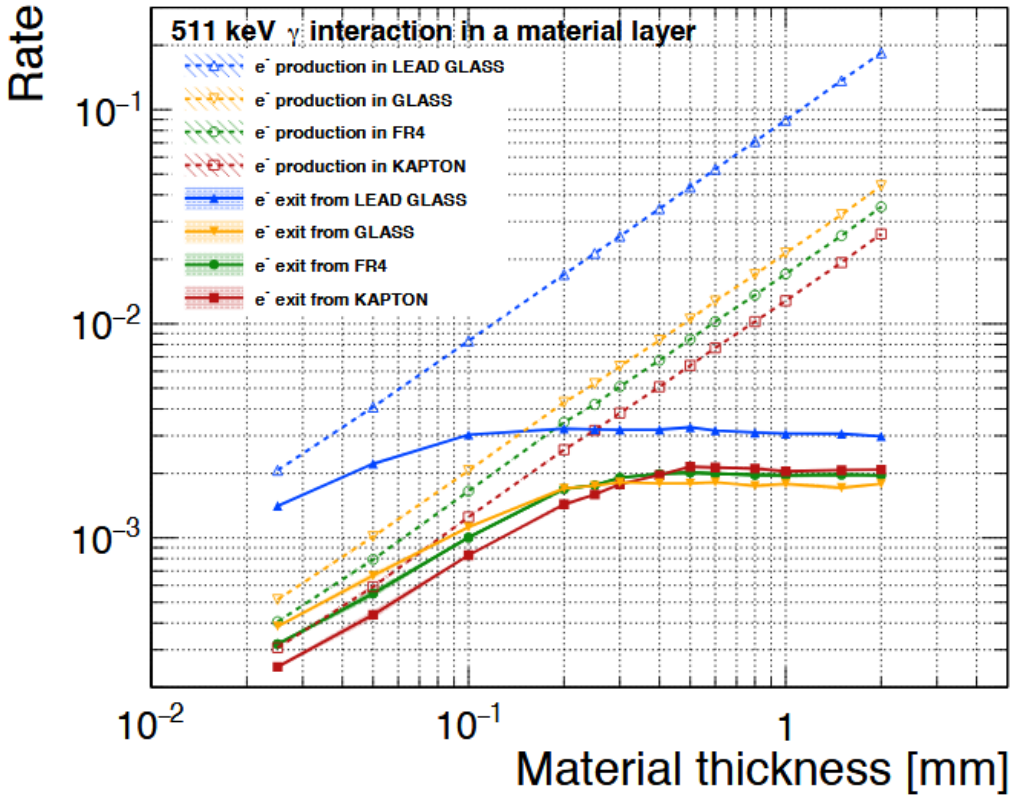
Future HEP experiments



TOF-PET

Simulations with GEANT4
Nucl. Instr. Meth.A 936 (2019),449





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Thank you for your attention