Gating device

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Do we need Gate ?

How ?

GEM gate

Do we need Gate ?

MPGD has an ability to absorb ions by order of 10^{-2} ~10^{-3}

If we use in Gain 10^3,

# of feedback ions is same as that from primary ions

--> the same number of ions are condensed into a few mm disc instead of hole TPC volume from primary.

It has been a long unanswered question how this dense disc affect to drifting electron

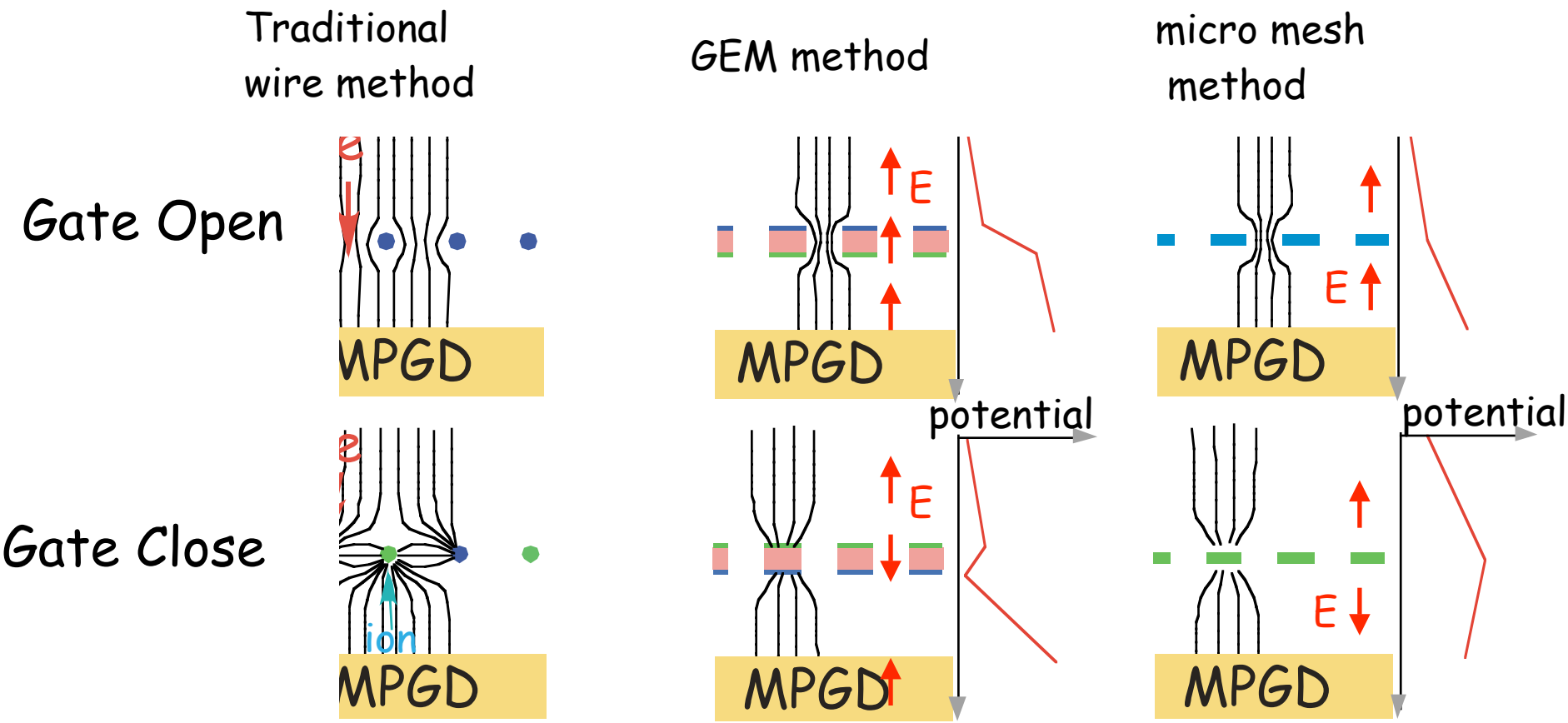
We have expected someone answer this, but nothing has come.....

Unless someone conclude this question as we don't need Gate,

We have to prepare gating device !!

How do we Gate ?

We can imagine 3 methods easily.



Wire :

wire spacing would be large enough
not to deteriorate resolution by ExB
wire spacing ~O(1 mm)
need stiff structure to stretch wires
Local change of E field around wires

GEM :

Electron transmission is in question
collection/extraction efficeincy
hole pitch ~O(100um)
need structure to hold GEM
No change of E field @ drift region

Micro mesh :

need thin mesh
for higher transmission
mesh pitch ~O(50um)

Larger change of E field
@ drift region

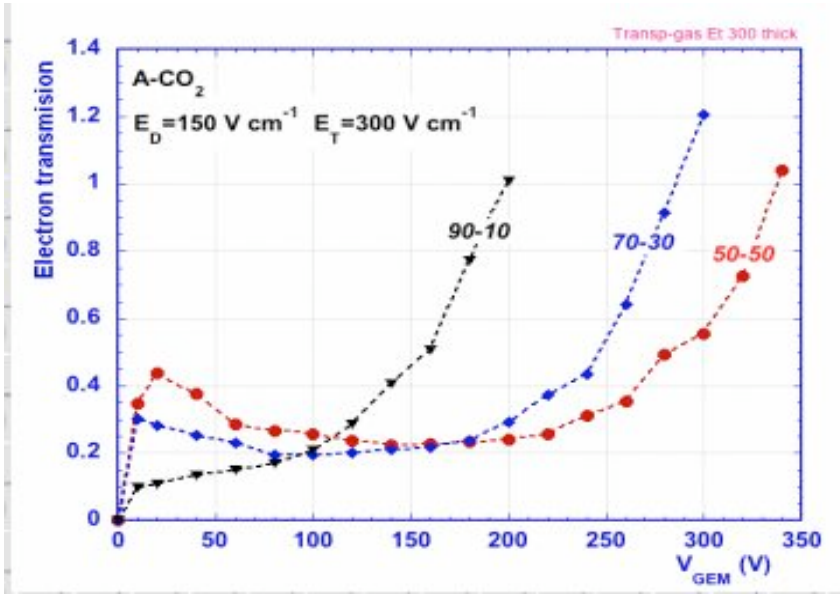
GEM gating

F. Sauli had proposed GEM as gating device @LBLTPC'06

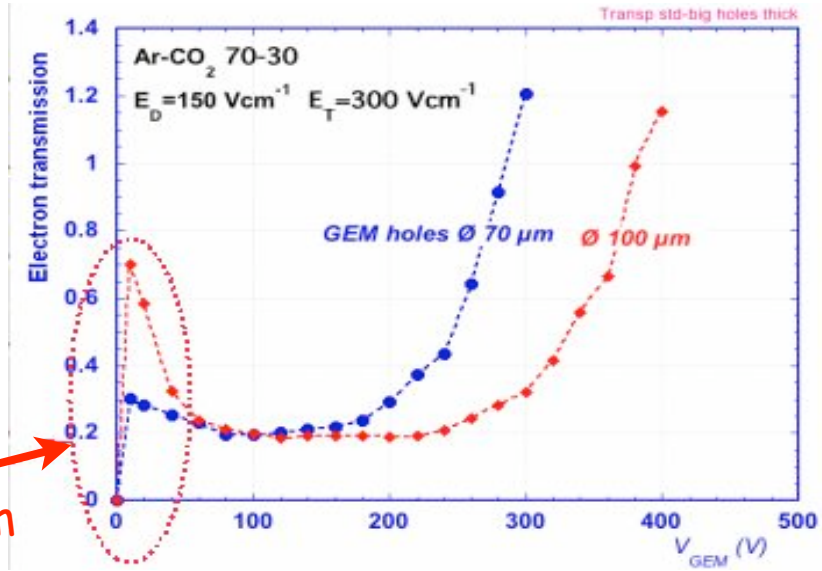
electron transmission is the key issue here !!

Electron transmission had been measured as a function of V_{GEM}

for different Gas mixture



for different hole size



10V/50um

~ 2kV/cm

Low voltage operation may give us good electron transmission:
where no gas amplification happen.

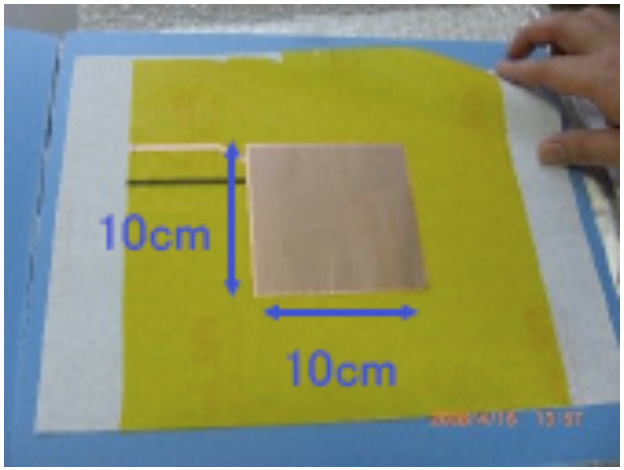
This result happen with only limited condition

Very difficult to find good operation point under strong B field

In case of our GEM gating

We have studied GEM as Gate

as it may fit easily with GEM module

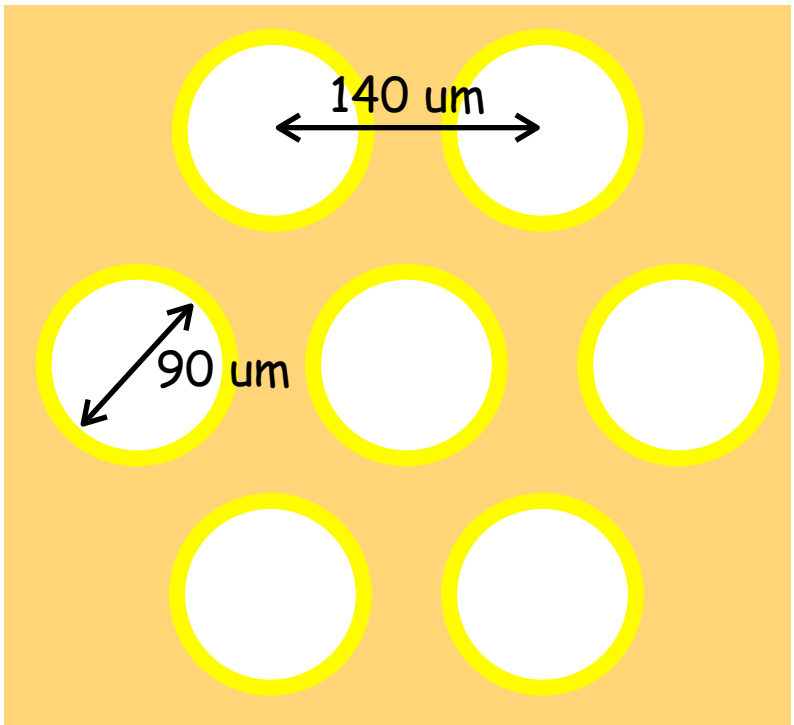


material thickness electrode, insulator -> thin

hole aperture as large as possible

insulator PI(FELIOS:Panasonic) 14um

electrode Cu 9um -> ~5um(thinning) (1~2um:goal)



ratio of hole 32 %

electron transmission of GEM gate

Method of Measurement

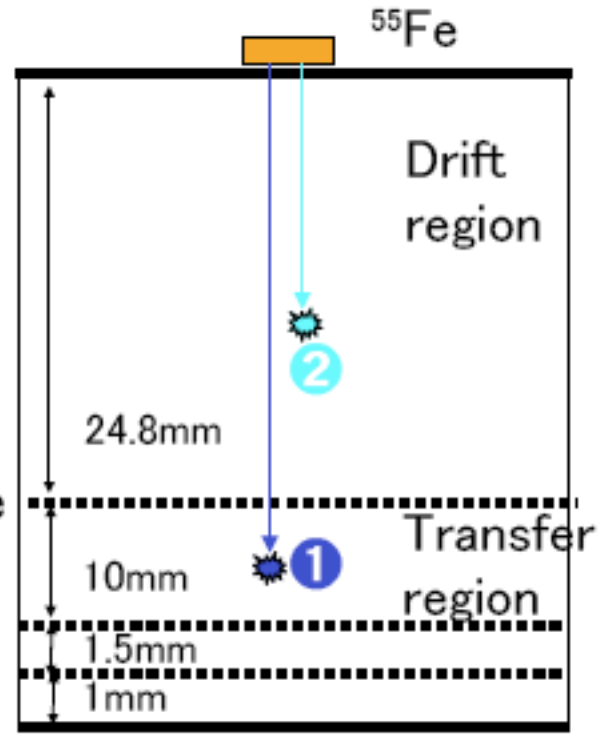
- Electron transmission efficiency
  - Ratio of ❷ to ❶

❷conversion at drift region

Electron loss by Gate

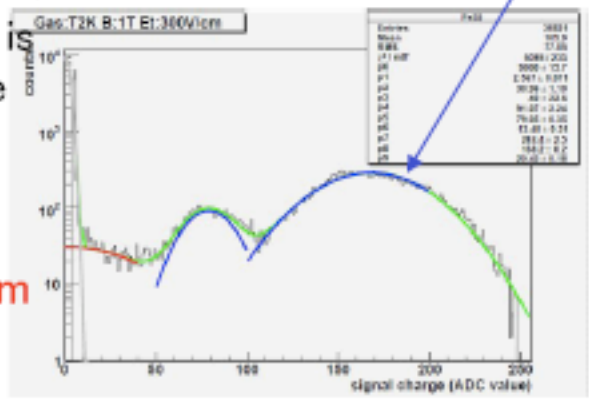
❶conversion at transfer region

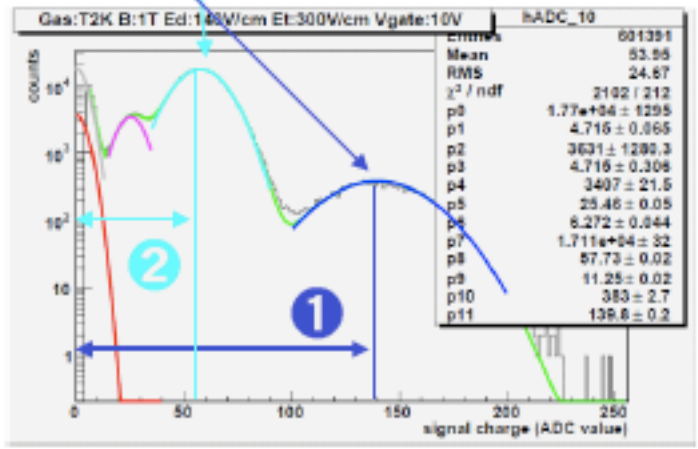
No effect by Gate
(ie. trans. eff. = 1)
E_D=0[V/cm]



Low rate because transfer region is far from source

Signal charge spectrum (log scale)



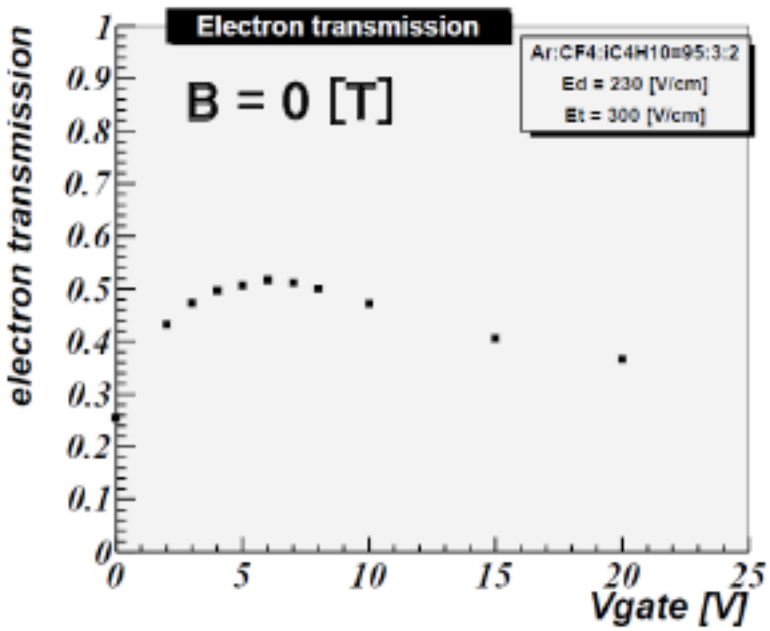


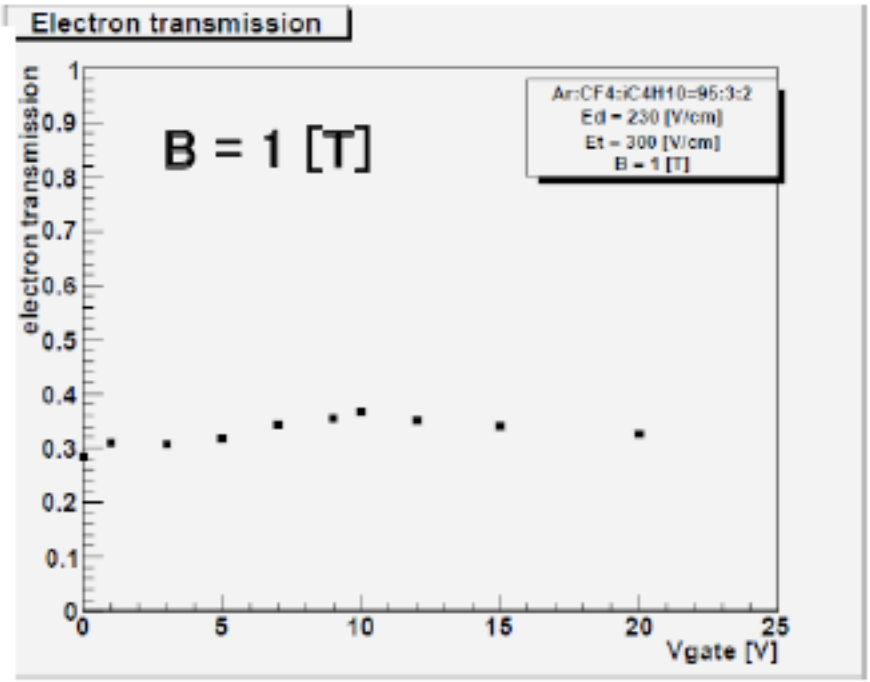
Peak position decided by gaussian

B = 1T
T2k gas

E_D = 230 [V/cm]
E_T = 300 [V/cm]

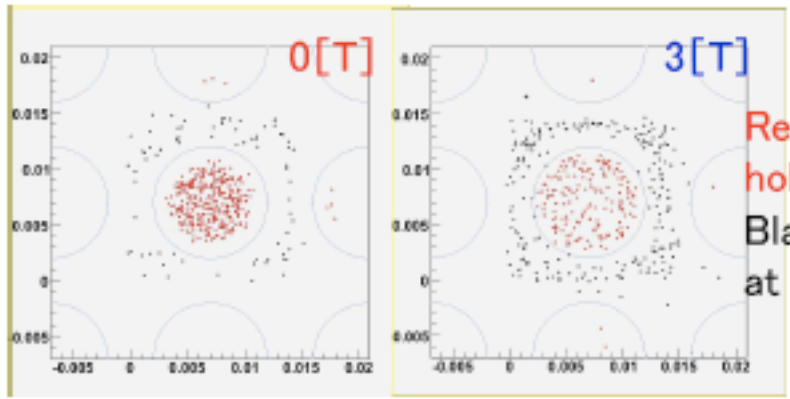
Transmission





- B field dependency

High B field ⇒ Electrons
move along B field due to lorentz angle,
# of electrons into the hole decreases



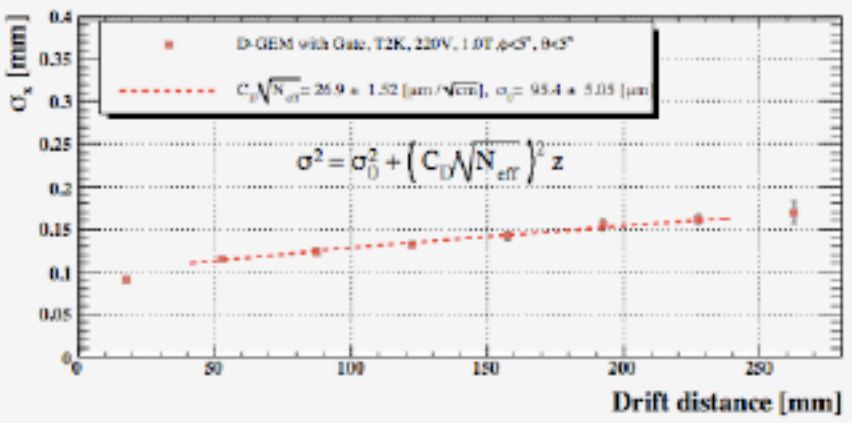
Red : into the hole
Black: arrived at electrode

Another method to estimate Electron transmission

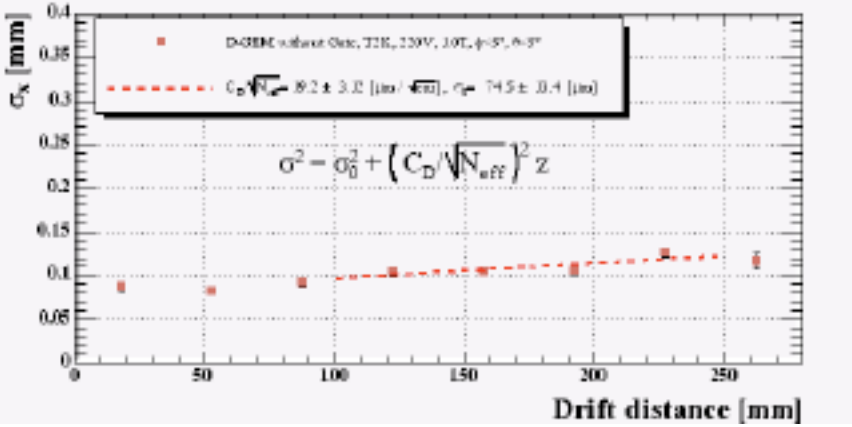
From change of Neff in resolution plots for MP-TPC with and w/o Gate

B = 1T
T2k gas

with Gate



without Gate



Neff = 9+-1

Neff = 19+-2

Transmission is ~ 50%

Current GEM gate provides only

~(less than) 50 % transmission

this correspond to aperture ?

under high B field electron may follow B field line rather than E

In order to improve transmission,

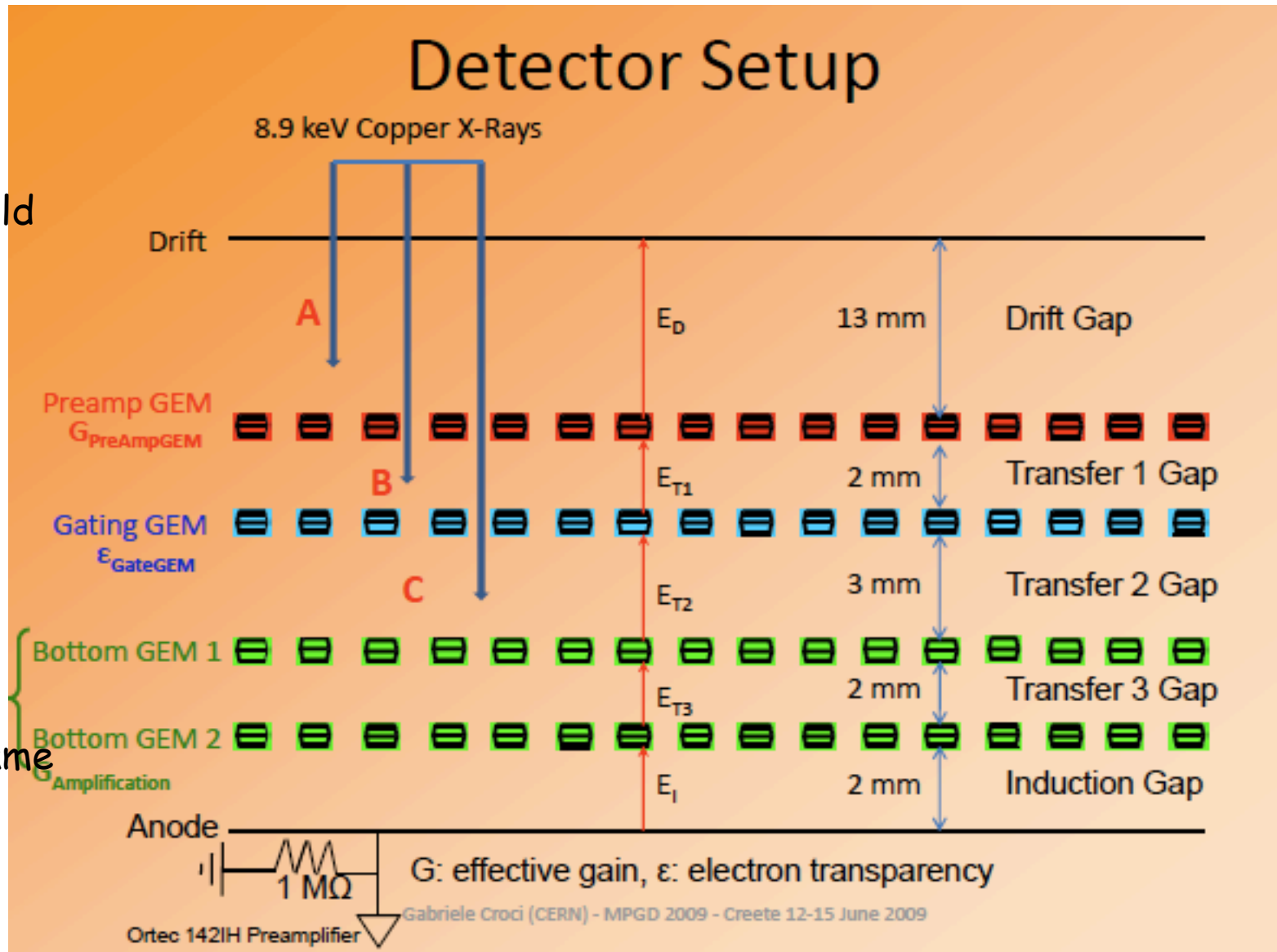
you need to **increase** **hole area** (larger hole)

reduce thickness

Sauli's proposal

Sauli propose to add Pre-amplification GEM
in order to recover number of electron

Sauli's @MPGD2009



But I think this idea would not help for our case.

NOTE
ion feedback exist !!

position resolution would not be recovered.

Pre-amp GEM also has same effect as Gate suffer

How about wire ?

As far as wire is thin enough, transmission will not be affected.
At most 10% degradation of resolution

But still I cannot imagine how we setup wire on LP1 GEM module
how to minimize wire support
how to stretch wire, how to hold them on module

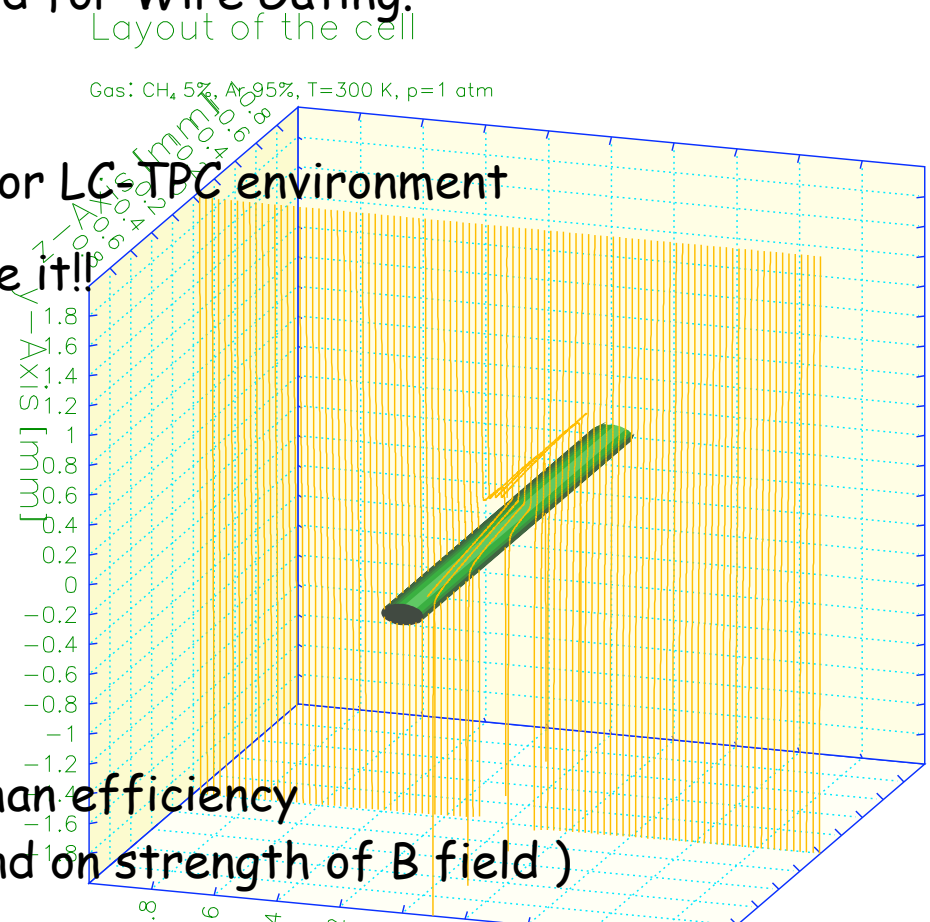
Current small module structure would not be good for Wire Gating.

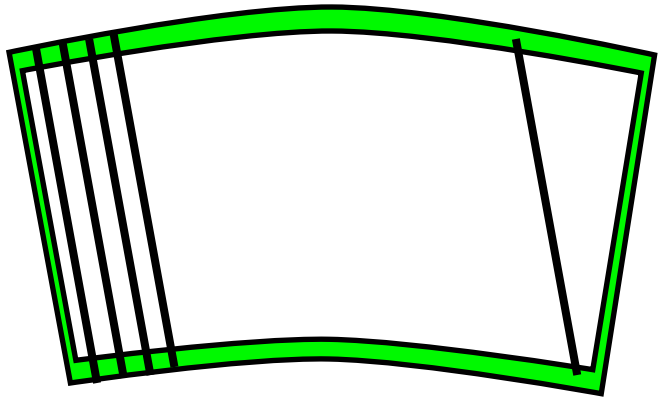
But wire is only established technique now,
someone must design wire gate for LC-TPC environment

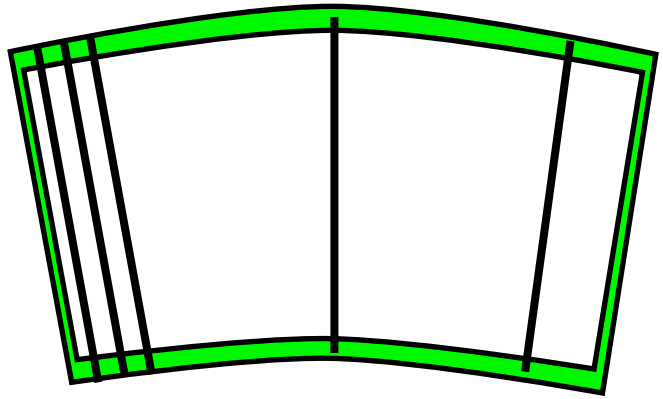
It is nice to hear DESY has a plan to make it!!

and should be tested in LP1

But event if it works well under B = 1T,
it must work under 4 T magnetic field.
(issue we have to worry about in wire gate
is deterioration rather than efficiency
and deterioration is highly depend on strength of B field)







Does this work ?

how to treat insulator

If we choose wire gate

better to reconsider the concept of LP1 (small module) again ??

Summary

It's good to hear DESY will try wire gate.

We will continue to improve GEM gate.

without BIG improvement GEM gate is unlikely to be chosen

If we prefer wire gate,

it's better to reconsider the concept of module.