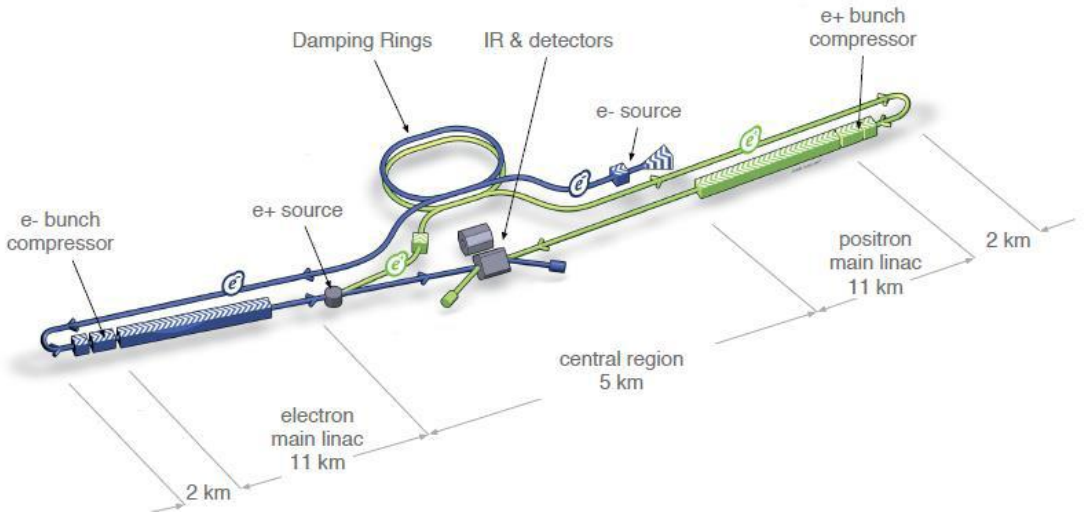
Test of GEM produced by Fujikura company

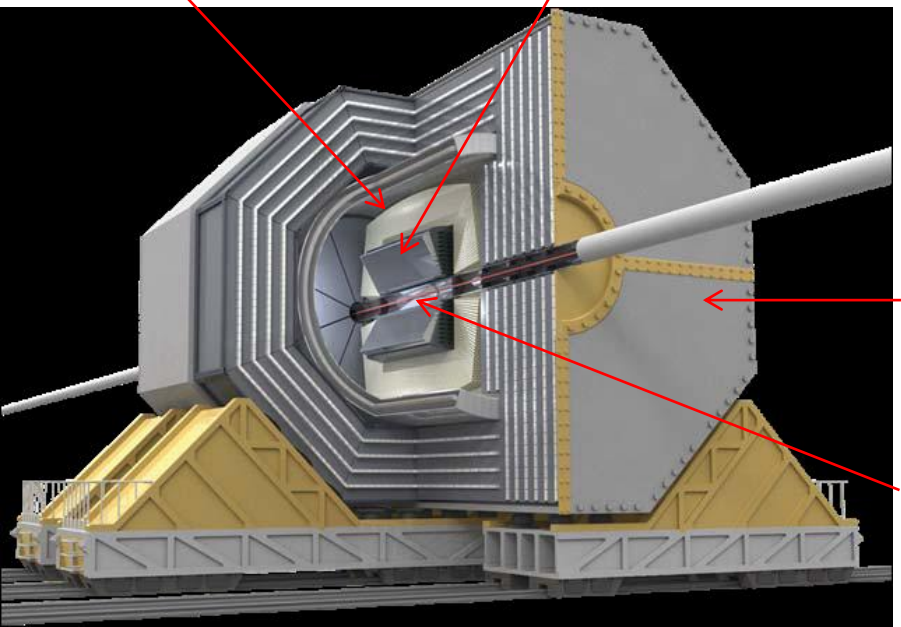
M1
Kazuki Sueta

ILC（International Linear Collider）



ILD detector

Calorimeter Central tracker(TPC)

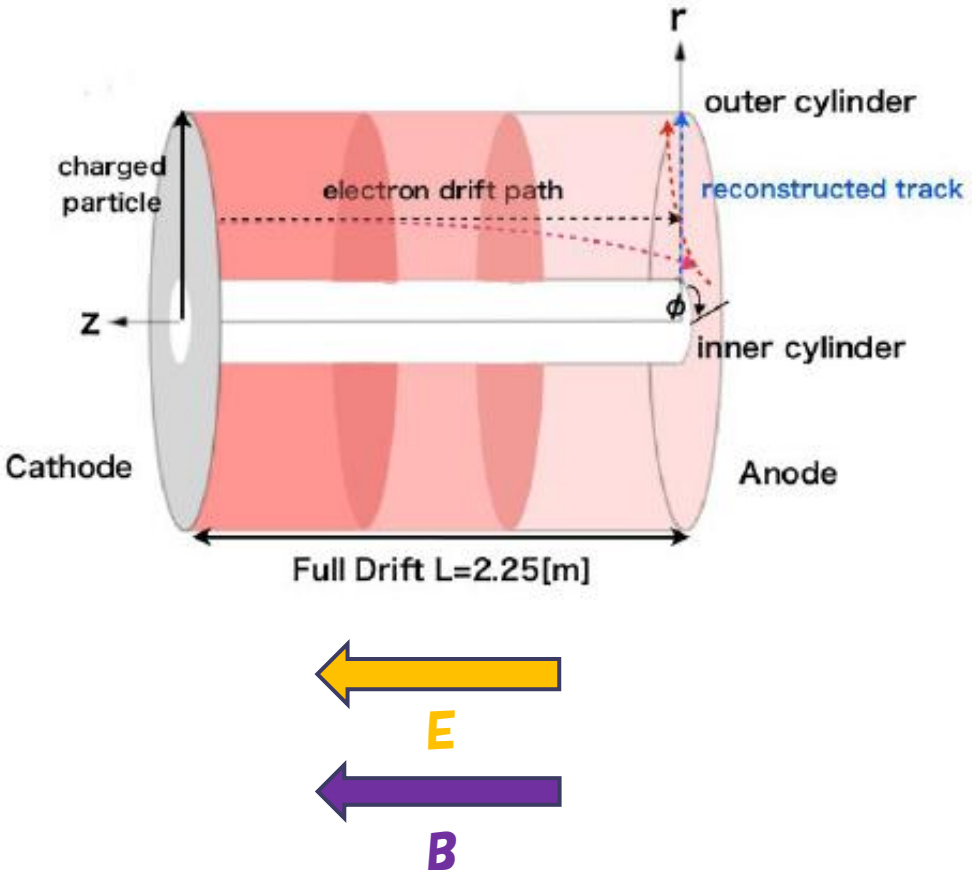


Central tracker of ILD is TPC.
So we study TPC.

Muon system

Vertex Detector

TPC(Time Projection Chamber)



We can reconstruct track by using three parameter r ,rφ and Z.

How to decide these parameter?
To measure

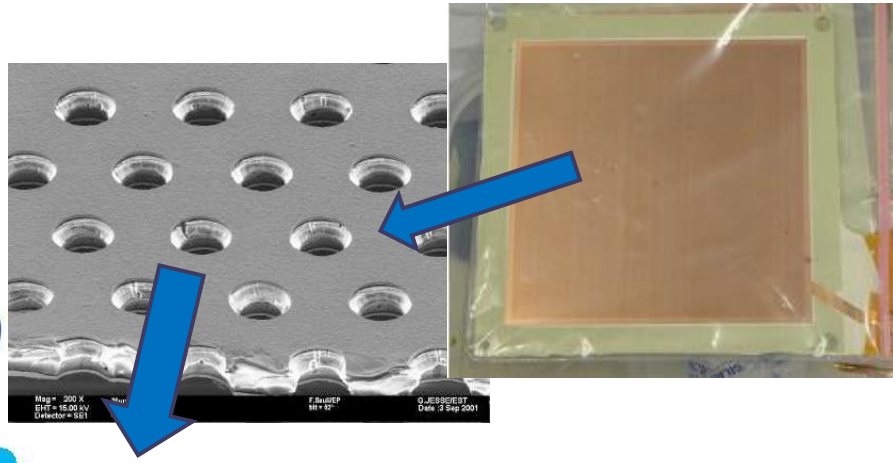
- r φ:Position of charge signal
  COG(Center value Of Gravity)
- Z:Drift time of electron

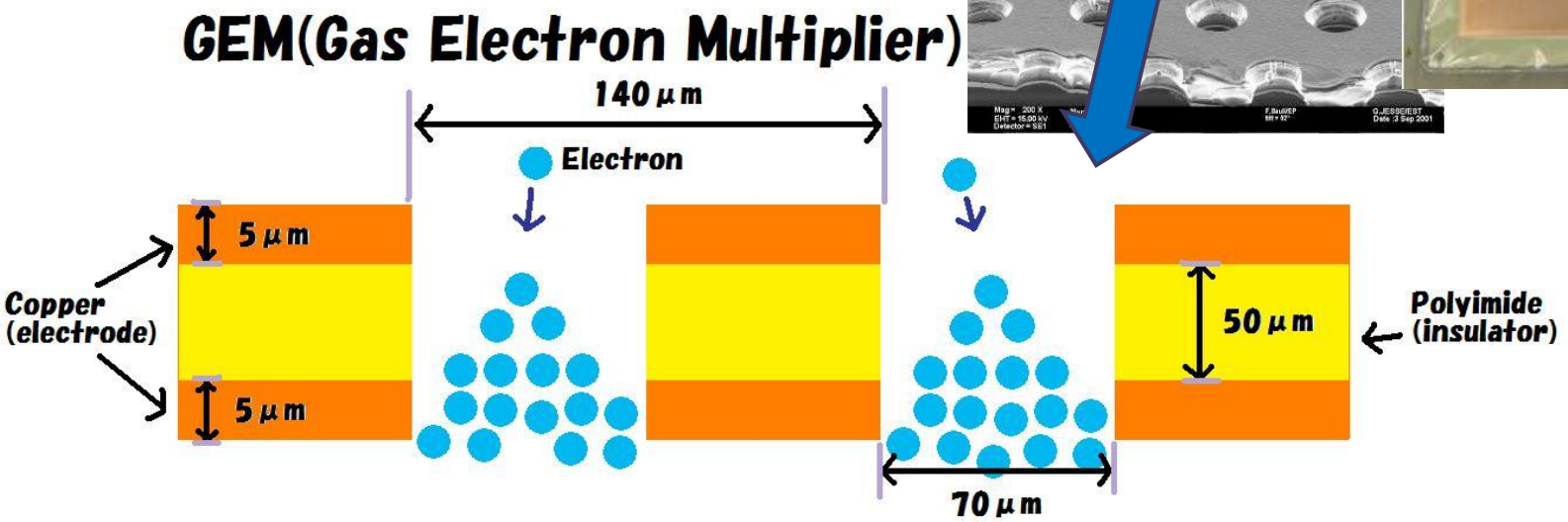
GEM is a one of the candidate for gas multiplication.

GEM(Gas Electron Multiplier)

- When (high) voltage difference is applied between upper and lower electrodes, electrons are multiplied.
- We can read charge of electrons.

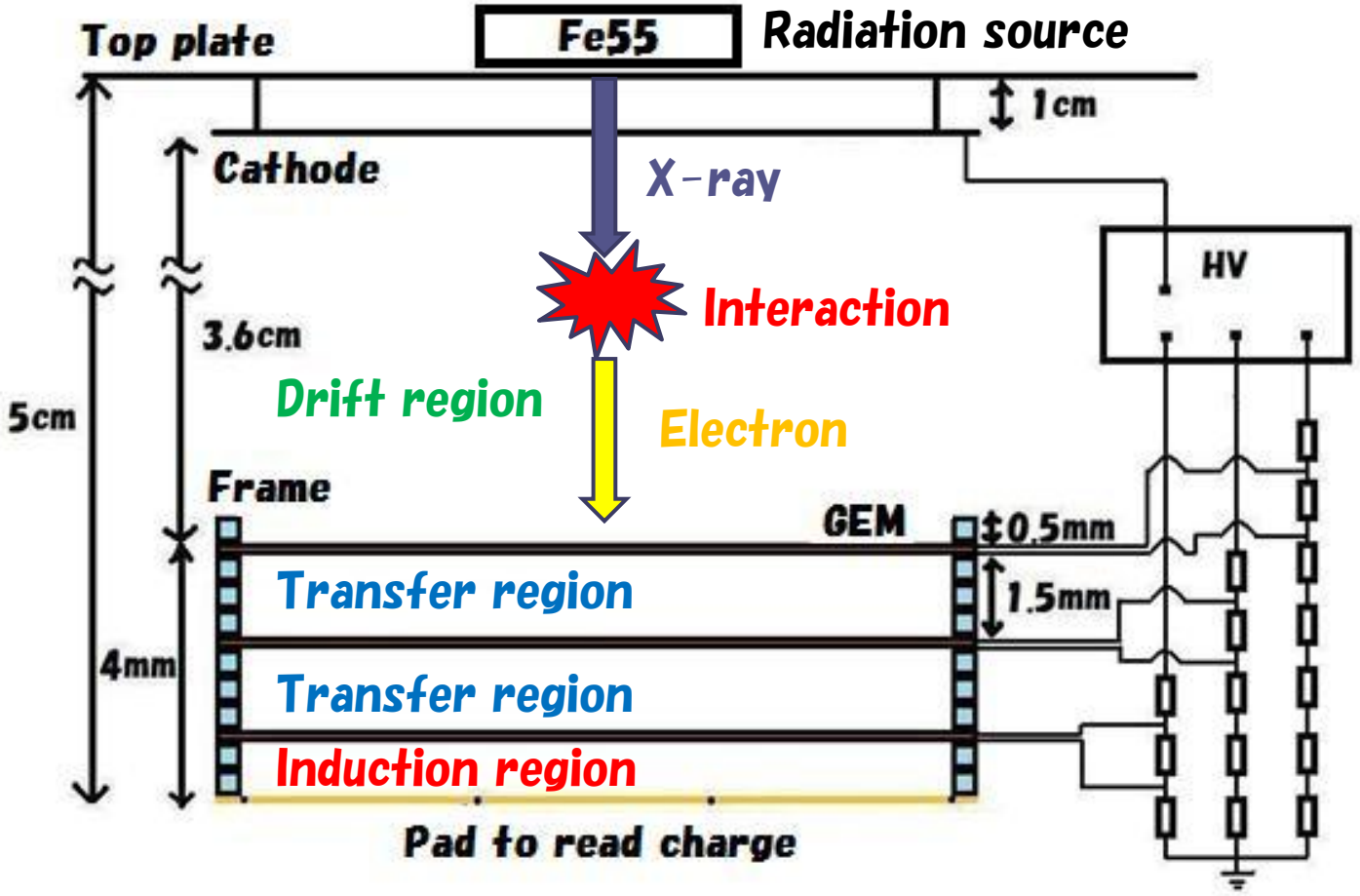
This figure and two pictures show the GEM produced by Scienergy company.





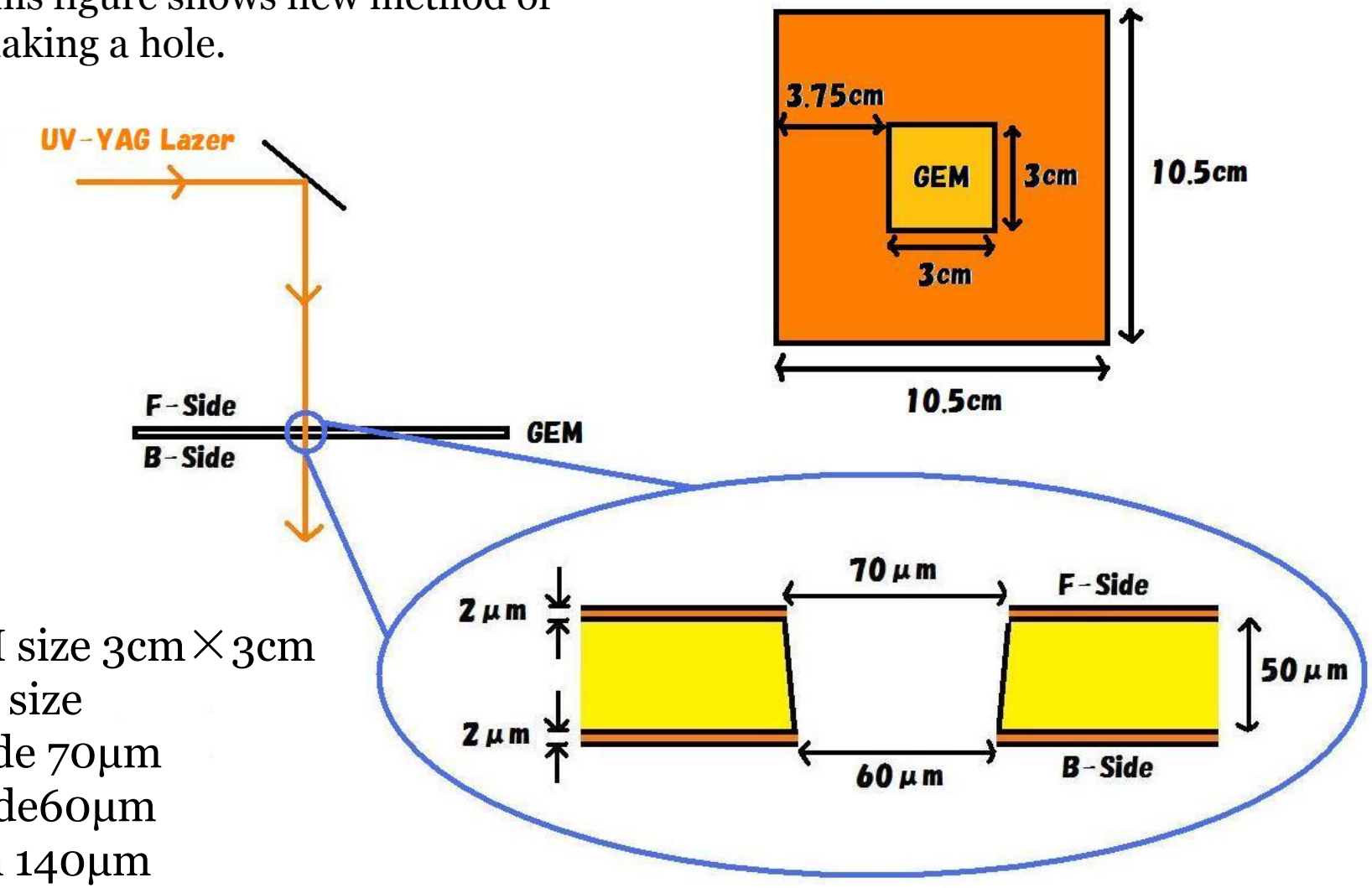
Test Chamber

- We measure gain of new GEM.
- The chamber is filled with P10 gas(Ar:CH4=90:10).
- X-ray interact with gas atom in drift region, and ionized electrons start to drift to GEM.



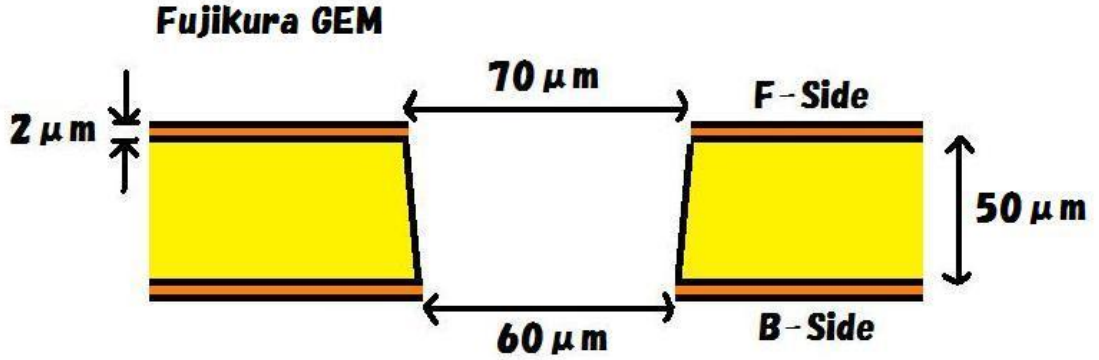
New GEM produced by Fujikura company

This figure shows new method of making a hole.

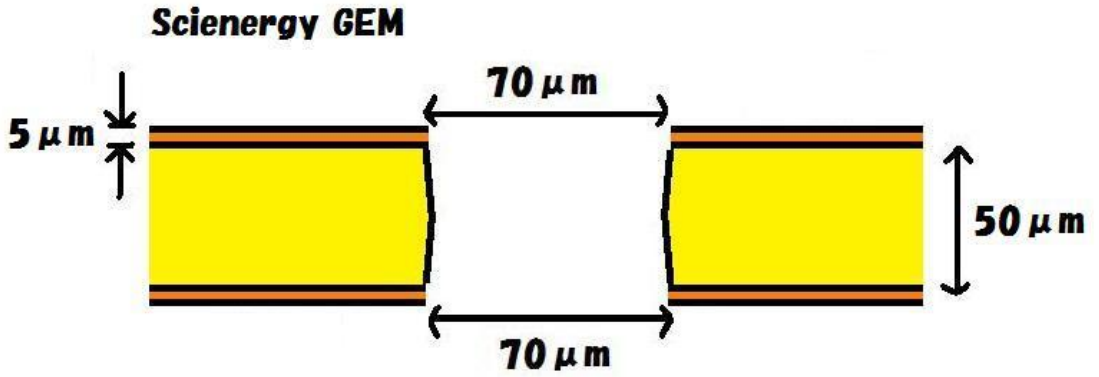


- GEM size 3cm×3cm
- Hole size
  F-side 70μm
  B-side60μm
- pitch 140μm

Fujikura GEM and Scienergy GEM



Hole size of F-side is bigger than B-side.



Hole size is same at both side.

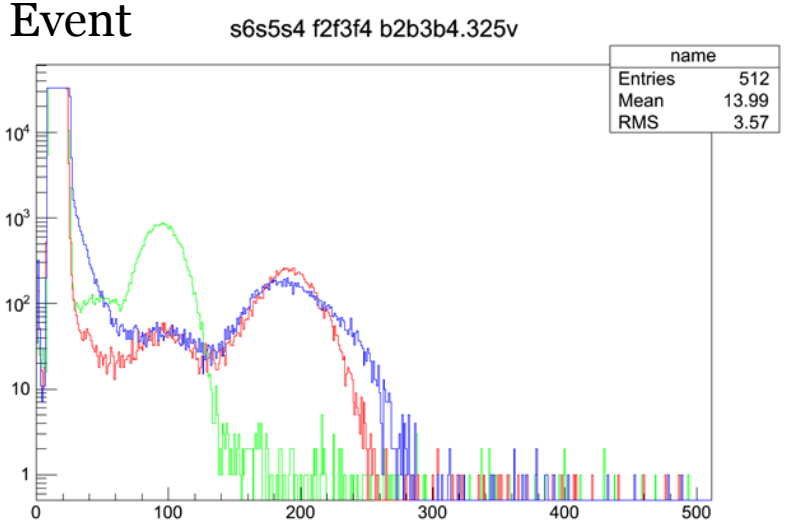
Hole of Scienergy GEM is made by Co2 laser(thermal process), but Fujikura GEM is made by UV-YAG laser. So these GEMs have different hole size.

We have to check performance of Fujikura GEM.

Experimental data

Energy spectrum of X-ray

Event

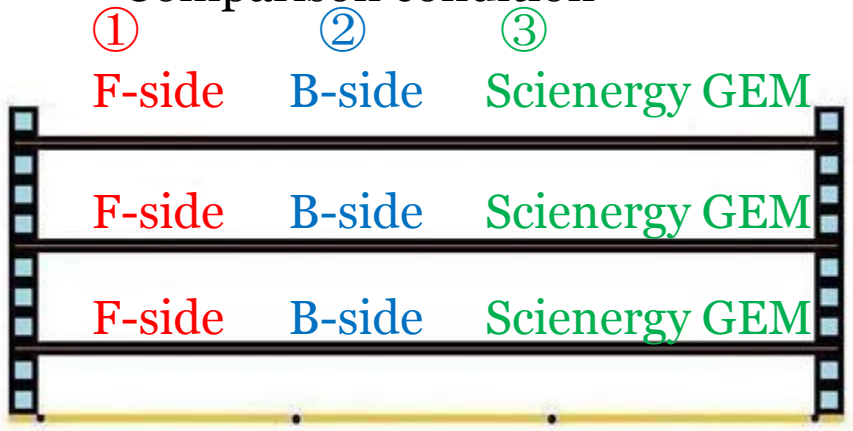


Energy(ADC channel)

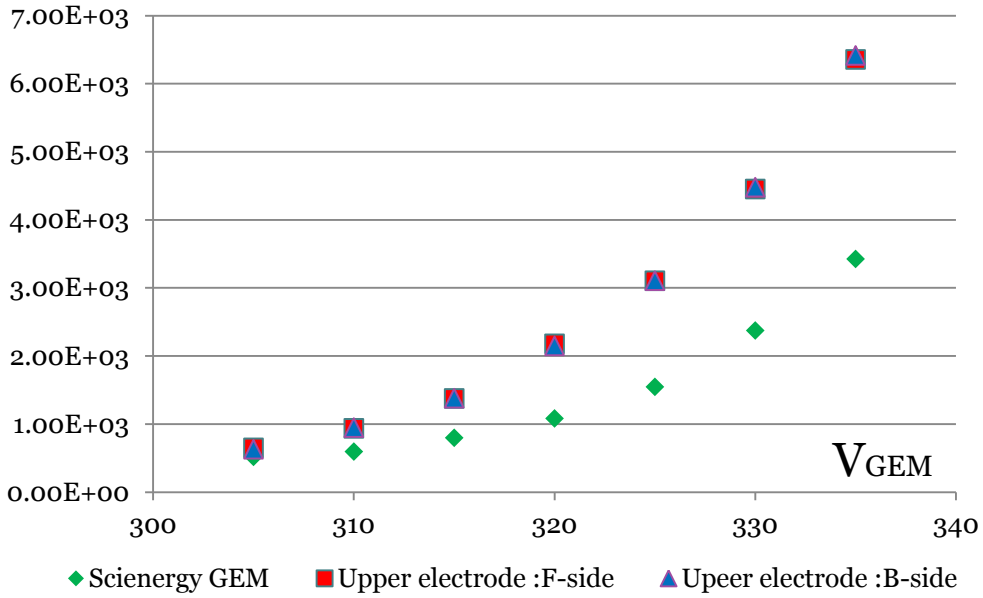
We compared Fujikura GEMs and Scienergy GEMs.

We checked Fujikura GEMs have enough gain .

Comparison condition



Gain



Next

- We checked gain of Fujikura GEM that is made by UV-YAG laser technology.
- UV-YAG laser technology is useful method.

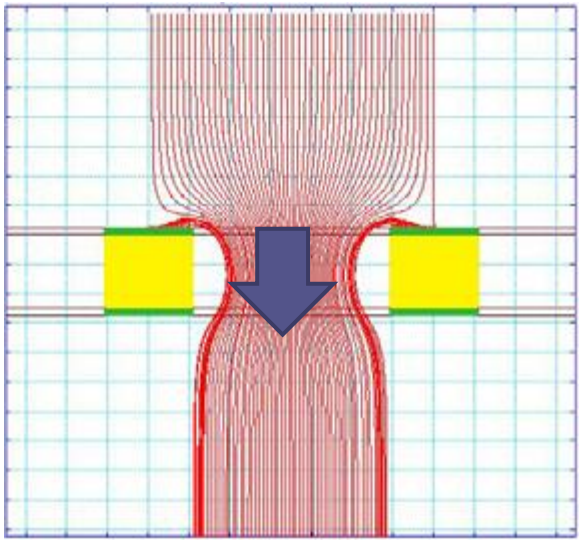
- We want to apply this technology to produce gate GEM.
- Aperture of Gate GEM have to be high, because we want to get good transmission.
- UV-YAG laser technology has high accuracy of making a hole. We expect that we can get high aperture of gate GEM.

Gating system by GEM

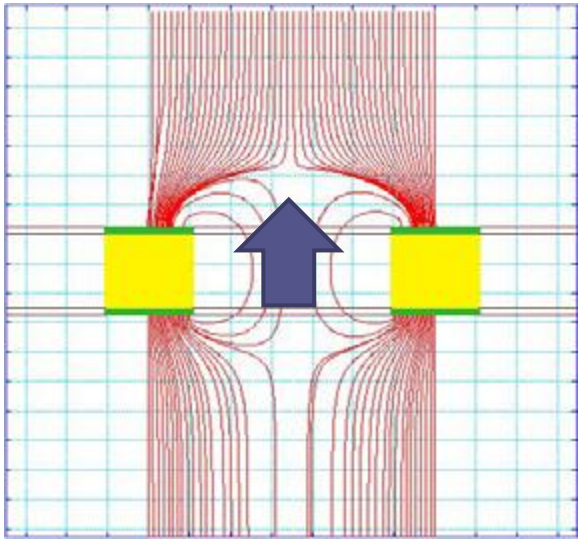
When electrons are multiplied, many ions are produced and go back to drift region and make ion disc.
These ions have to be stopped by using gate.

Switching potential

Open



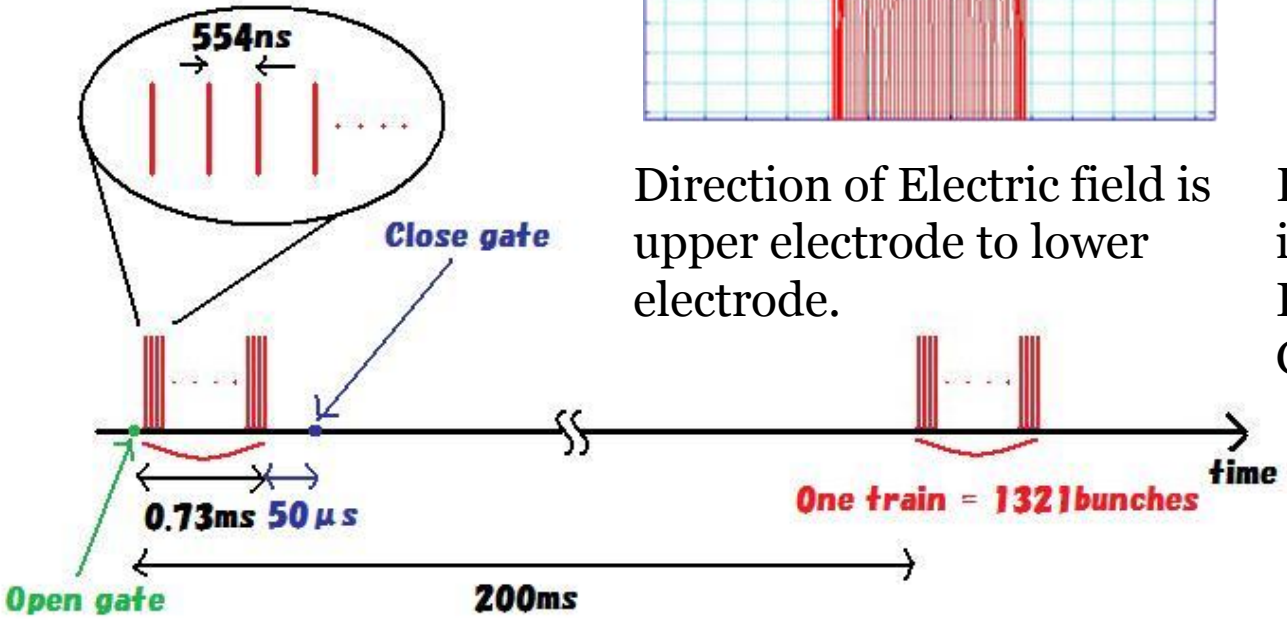
Close



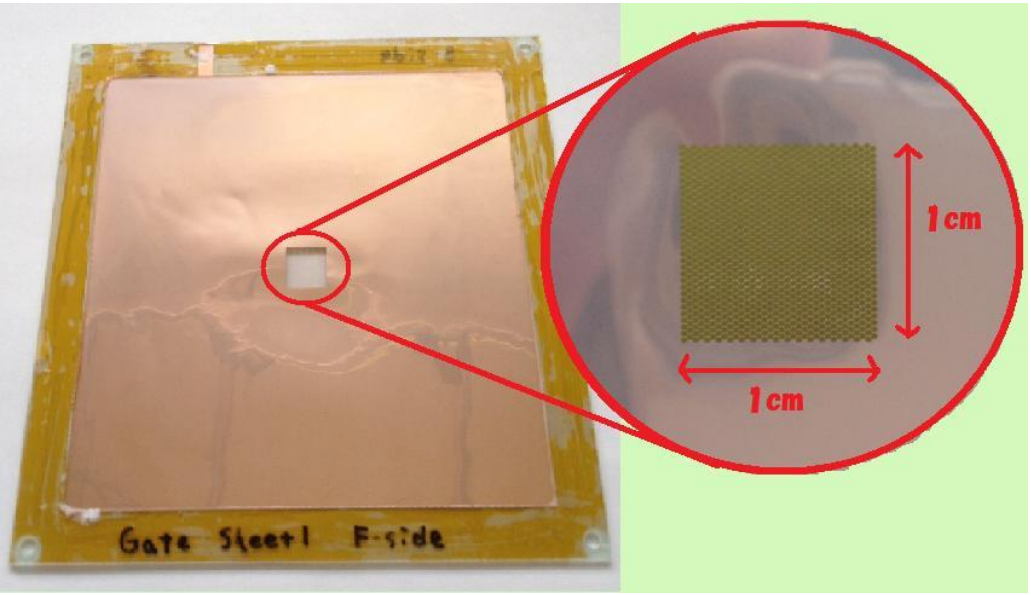
Direction of Electric field is upper electrode to lower electrode.

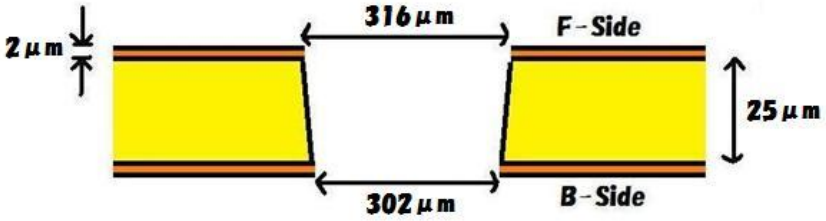
Direction of Electric field is reversed.
Ions are stopped by gate GEM.

Beam pulse structure



Gate GEM produced by Fujikura company





- Hole size
  F-side 316μm
  B-side 302μm
- Pitch 330μm

This sample is in this case.

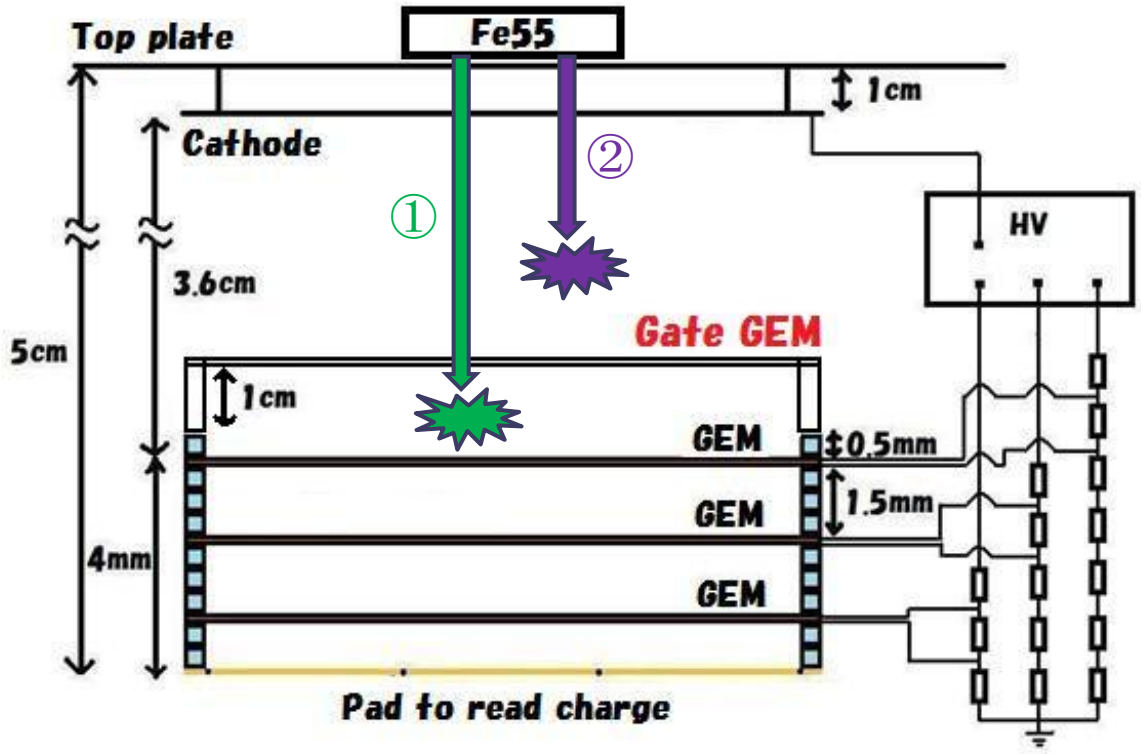
hole size(μm)	pitch （μm)	aperture ratio （%）
300	390	53.60946746
300	360	62.91666667
300	330	74.87603306
300	300	90.6

Performance of Gate GEM

- Ions can be stopped easily.
- Gate must provide good electron transmission, but it is not easy to improve.
- Making large aperture is a one of solution.
- The feature of precision process by YAG laser can make a bigger hole.

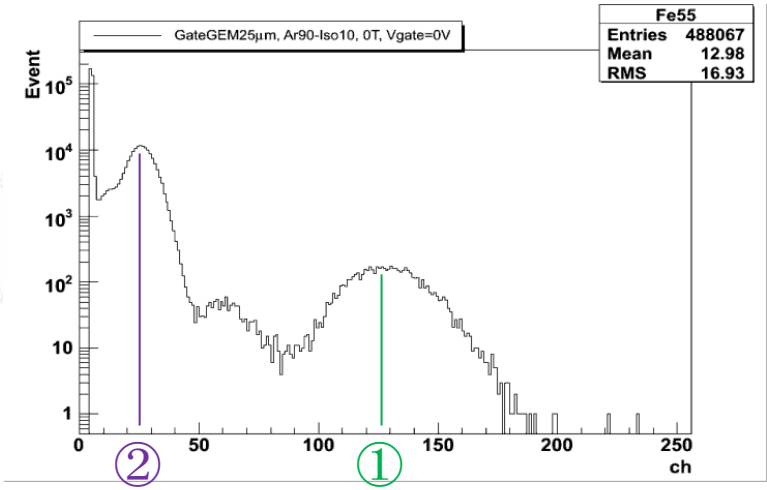
- We need to understand gate performance not only form data also from simulation.

Measurement of the electron transmission



We will measure the transmission of new gate soon.

Event



Energy(ADC channel)

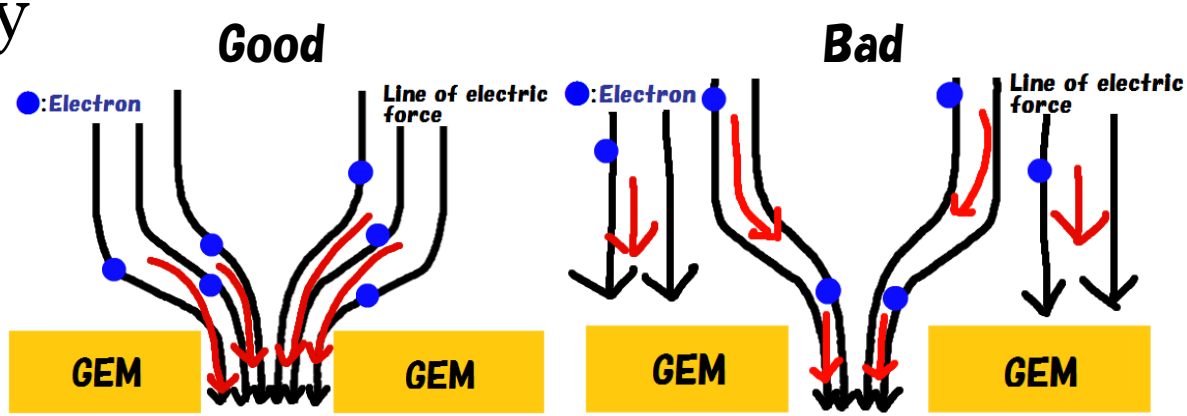
Interaction process ① is 100% transmission.
We can find transmission by this equation.

$$T=②/①$$

Collection efficiency and Extraction efficiency

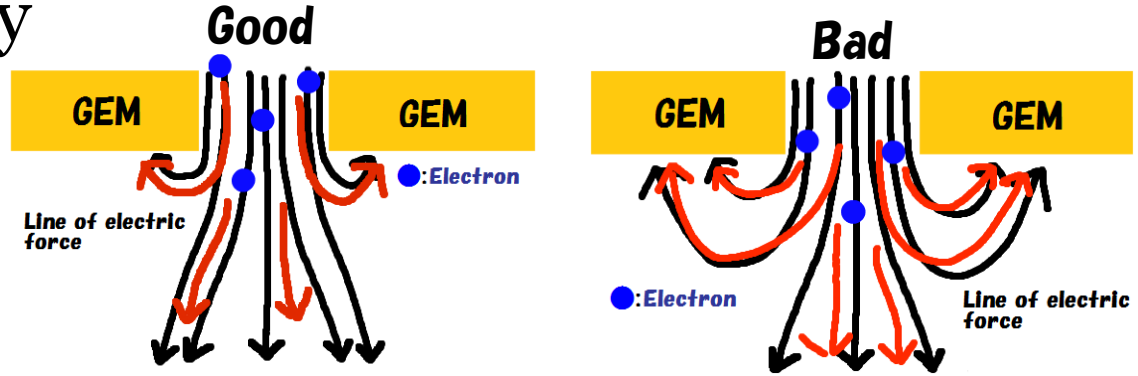
- Collection efficiency

$$C = \frac{n_{Hole}}{n_{Drift\ or\ Transfer}}$$



- Extraction efficiency

$$E = \frac{n_{Transfer\ or\ Induction}}{n_{Hole}}$$



n_{Hole} : The number of electrons that go into the hole

$n_{Drift\ or\ Transfer}$: The number of electron that is in drift region or transfer region

$n_{Transfer\ or\ Induction}$: The number of electrons that go out of the hole

Transmission

Electron transmission is given by this equation

$$T = \frac{n_{Transfer\ or\ Induction}}{n_{Drift\ or\ Transfer}} (= C \times E)$$

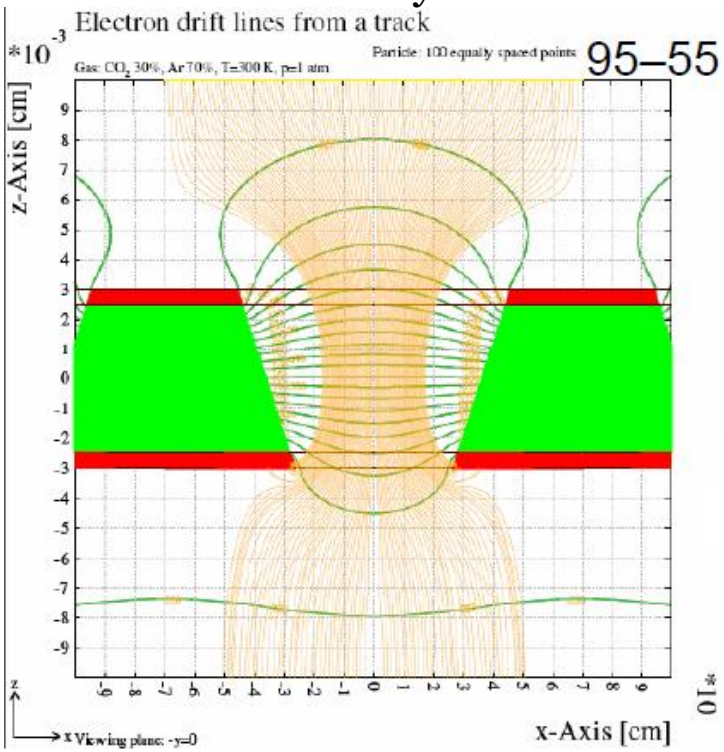
Aperture of Gate GEM have to be high, because we want to get good transmission.
UV-YAG laser technology has high accuracy of making a hole.
We expect that we can get high aperture of Gate GEM.

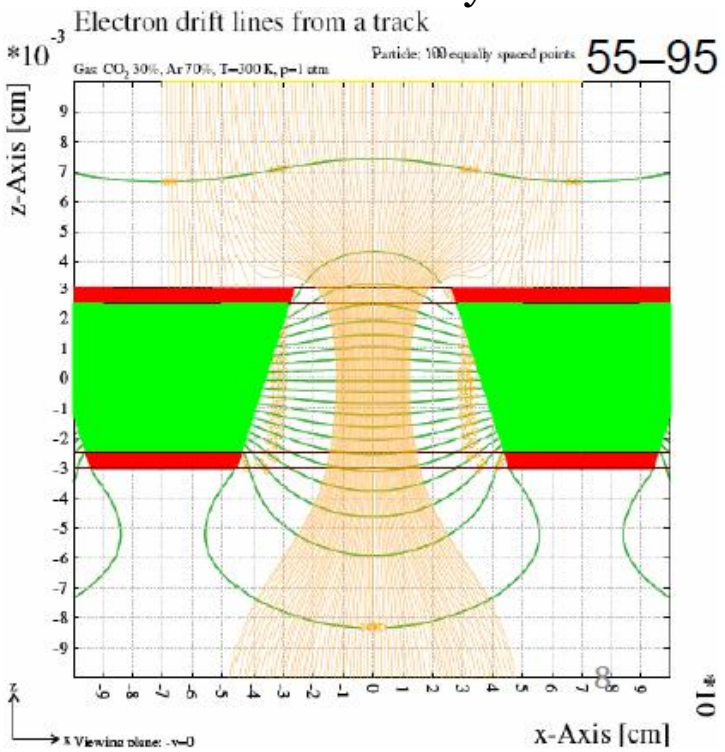
We will check how we can apply this technology of Fujikura company.

Electric field

When upper electrode is F-side, collection efficiency is good. But extraction efficiency is bad.

When upper electrode is B-side, Extraction efficiency is good. But collection efficiency is bad.

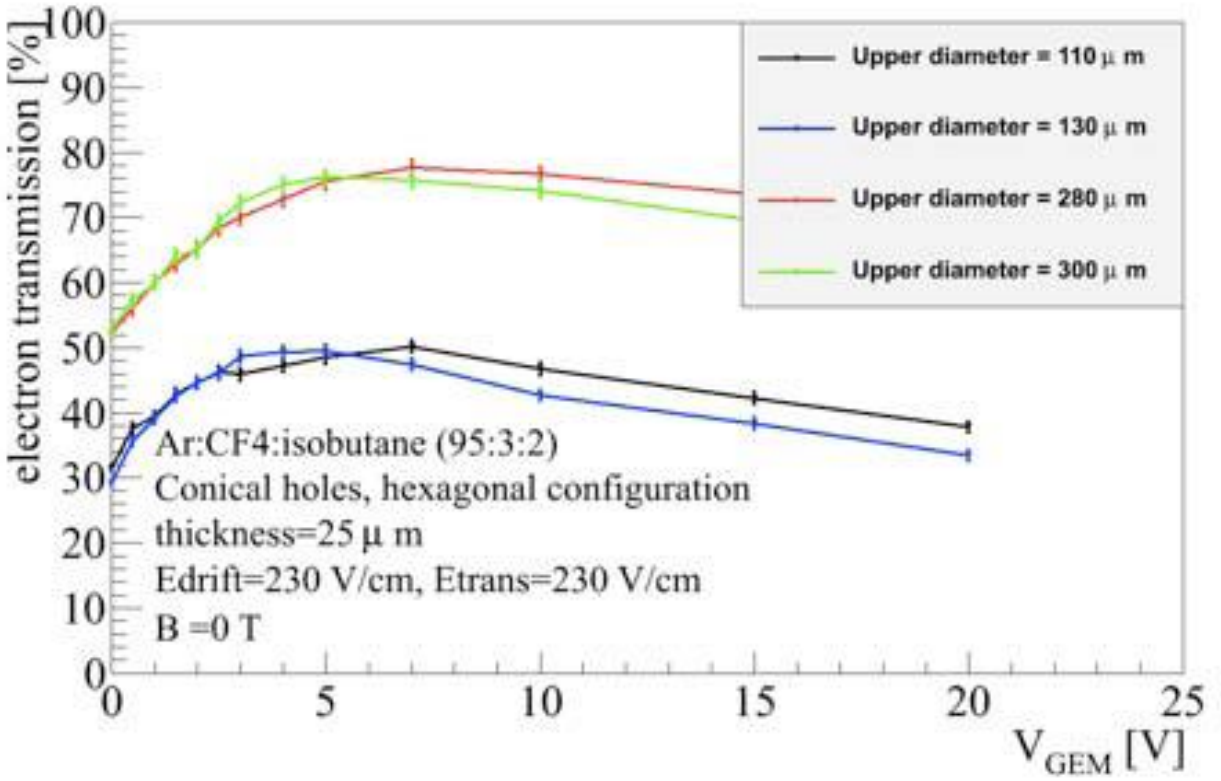




- Do Fujikura Gate GEMs have enough electron transmission?
- We have to study effect of different hole size at each side.
- Next page is result of Philippe's simulation.

Philippe's simulation for Fujikura Gate GEM

pitch 140um/330um
20um diff. in diam.



This graph shows Philippe's simulation for Fujikura gate GEM.

Red line means upper electrode is F-side. Green line means upper electrode is B-side.

In this case is using T2K gas.

According to this result, both side is not so different.

We have to compare experimental data and this result.

Summary

- Fujikura GEM have enough gain.
- UV-YAG laser technology has high accuracy of making a hole.
- We apply this technology to make gating system.

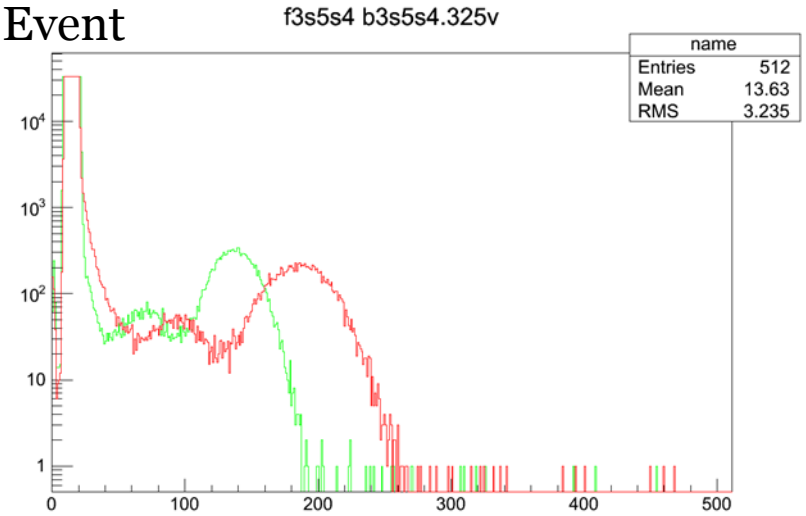
- We will measure the transmission of new gate soon, and compare the data to simulation result to understand performance of gate GEM.

Thank you!

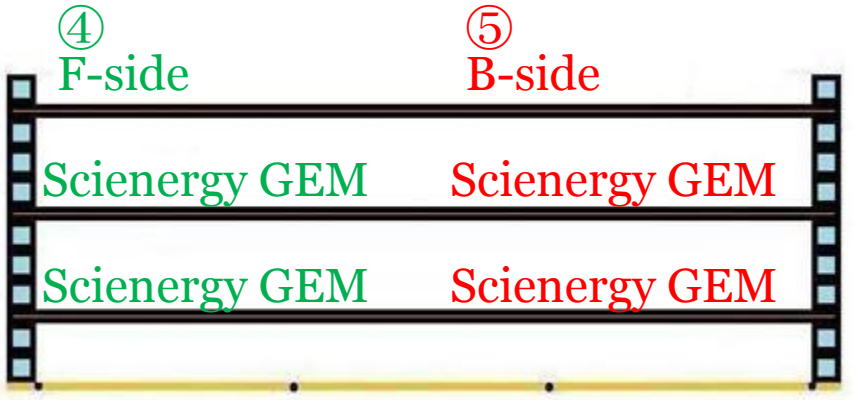
Back up

Data2

Event

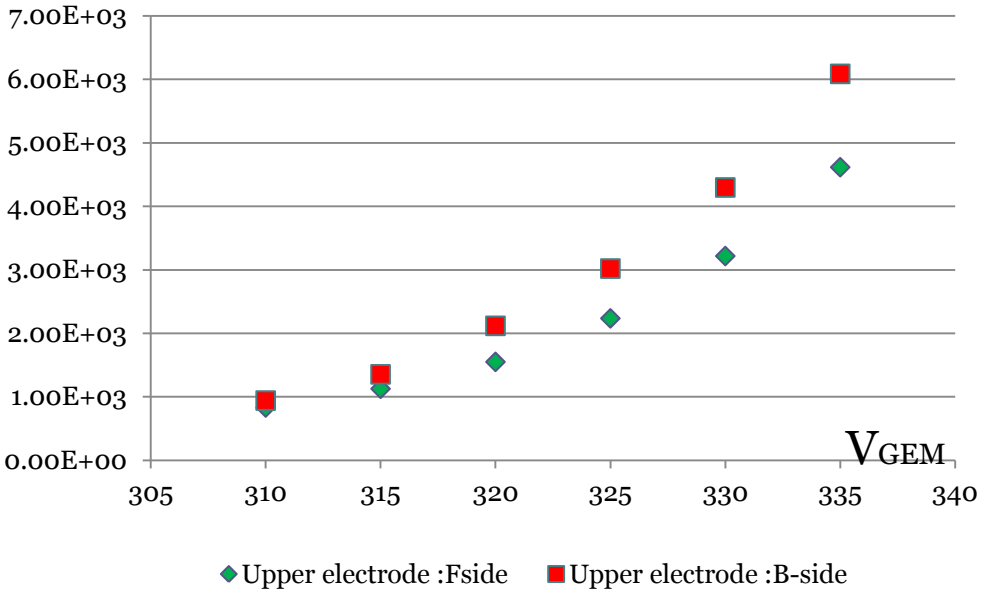


Comparison condition



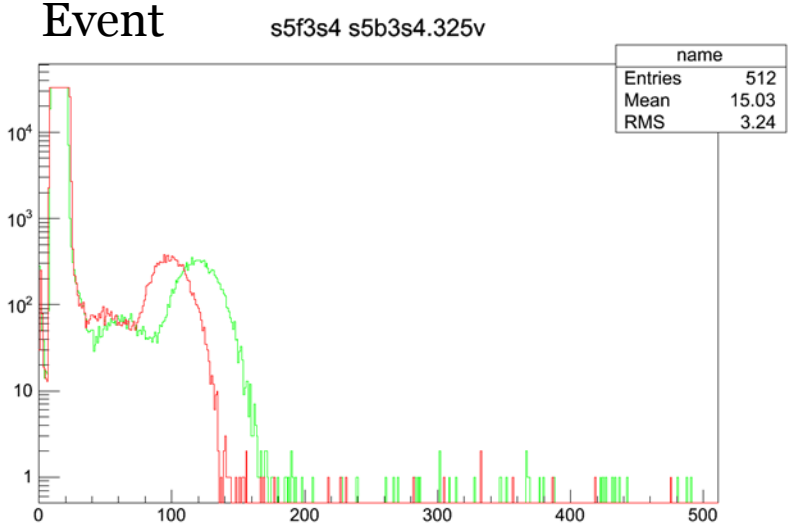
Gain of comparison condition⑤ is bigger than comparison condition④.

Gain



Data3

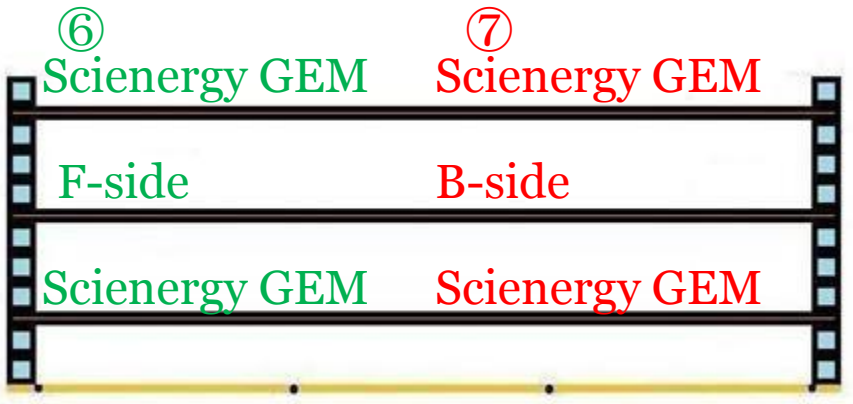
Event



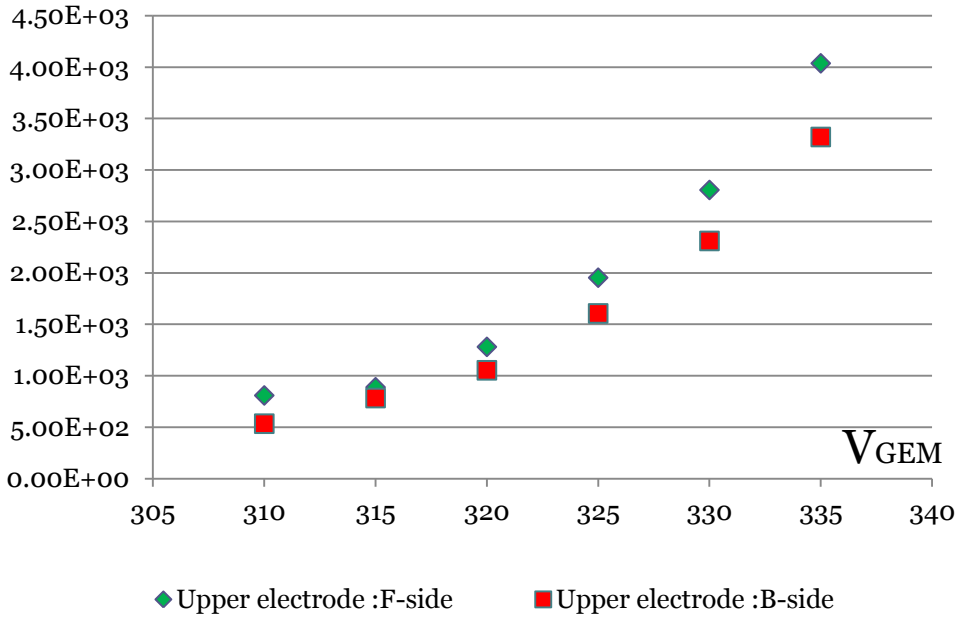
Energy(ADC channel)

Gain of comparison condition⑥ is bigger than comparison condition⑦.

Comparison condition

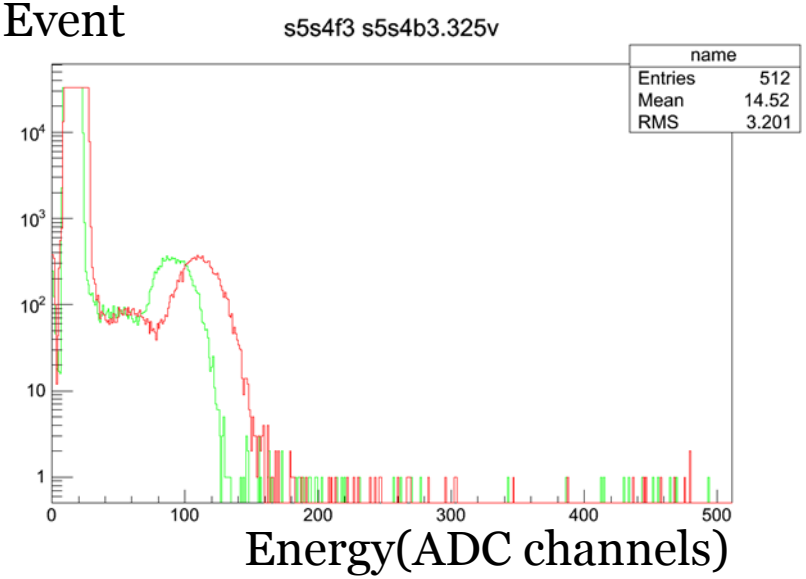


Gain

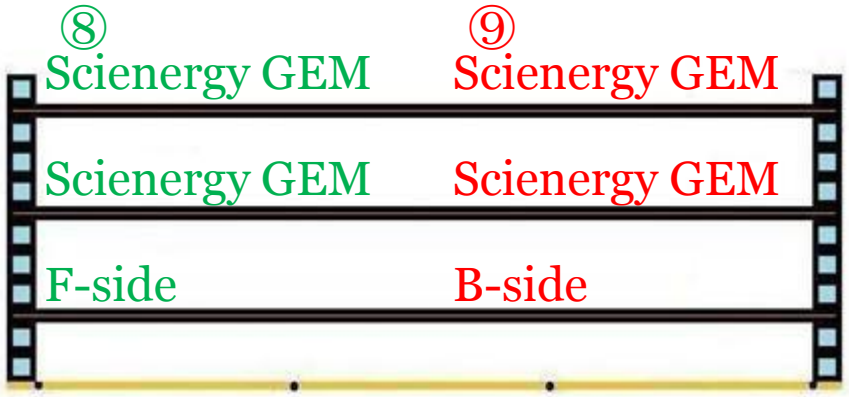


Data4

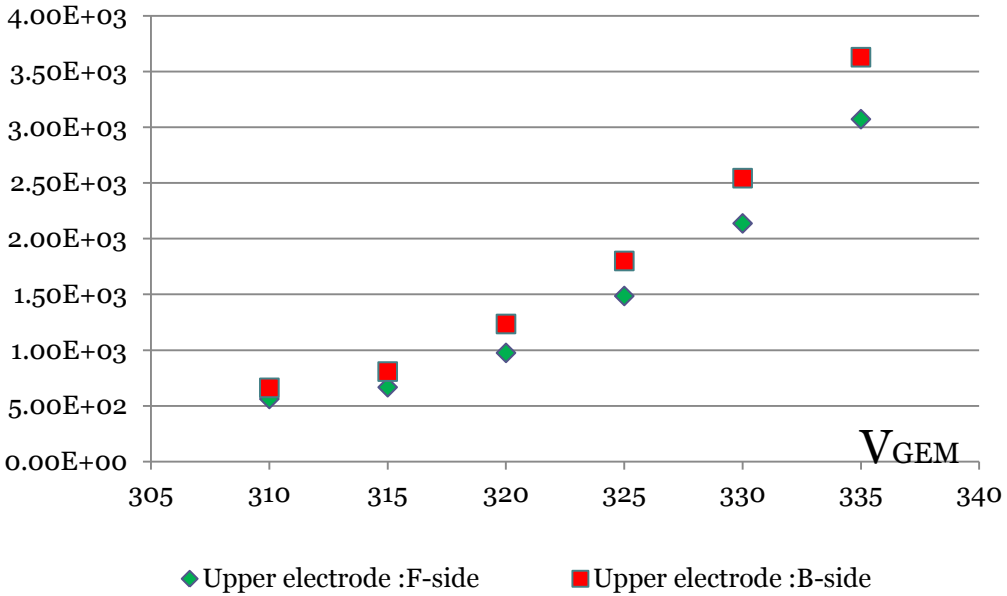
Event



Comparison condition



Gain



Gain of comparison condition⑨ is bigger than comparison condition⑧.