The fourth MPGD symposium

Tests of 2D GEM detector based on the CASAGEM

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Limin Duan, Rongjiang Hu, Herun Yang,Chenggui Lu, Peng Ma , Junwei Zhang(IMP)

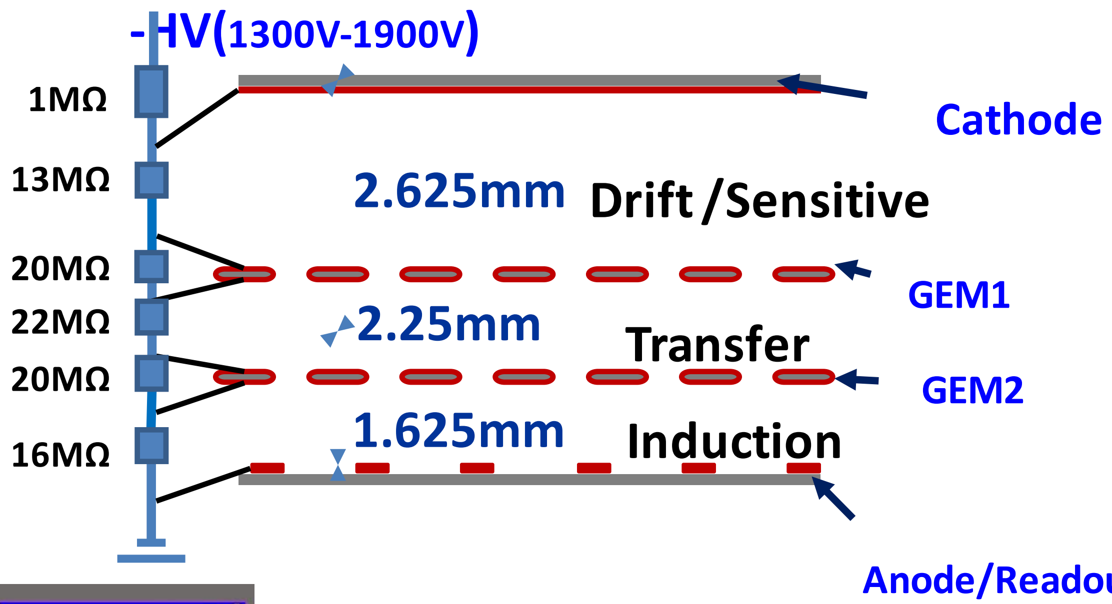
- The set up of CASAGEM system
- Test results of 2D GEM detector
- The effect of non-uniform inter-foil distance
- Status of large area GEM detector
- Summary and plan

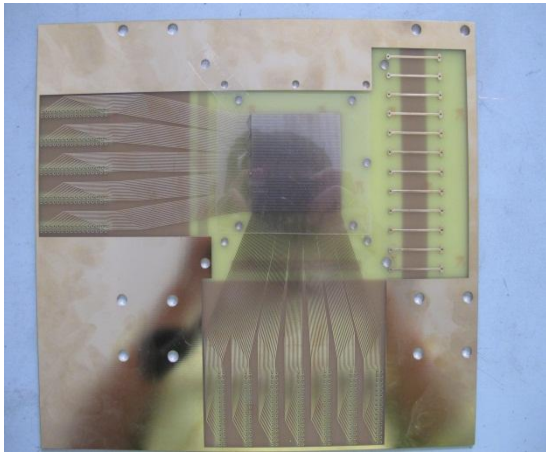
清華大學
物理系

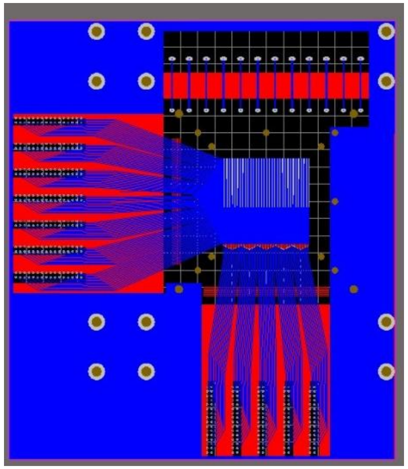
2014.07.19 Shandong University, Weihai

The set up of CASAGEM system

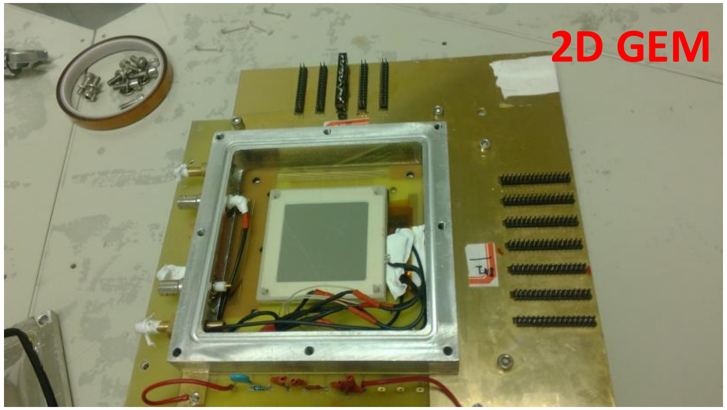
2D GEM detector







Design of Readout



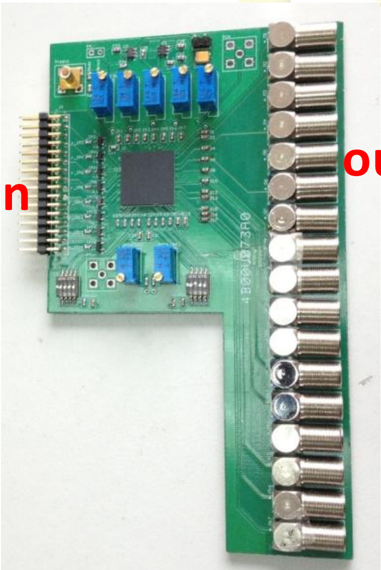
5cm*5cm

Collaborate with Prof. Limin Duan and his group, IMP

The set up of CASAGEM system

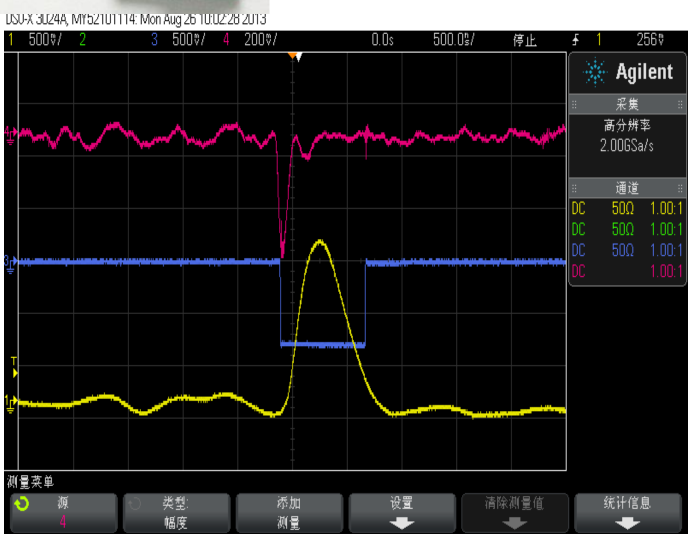
CASAGEM board

in



out

Gain	2~40mV/fC
Dynamic Range	0~1000fC
Shaping time	20~80ns
INL	<1%
Power	10mW/ch (Anode channel), 11mW/ch (Cathode channel)
ENC	<2000e (Anode channel, Input Cap: 50pF), <3000e (Cathode channel, Input Cap: 100pF)



Pink: signal from foil(trigger)

Blue: gate signal

Yellow: signal from the CASAGEM

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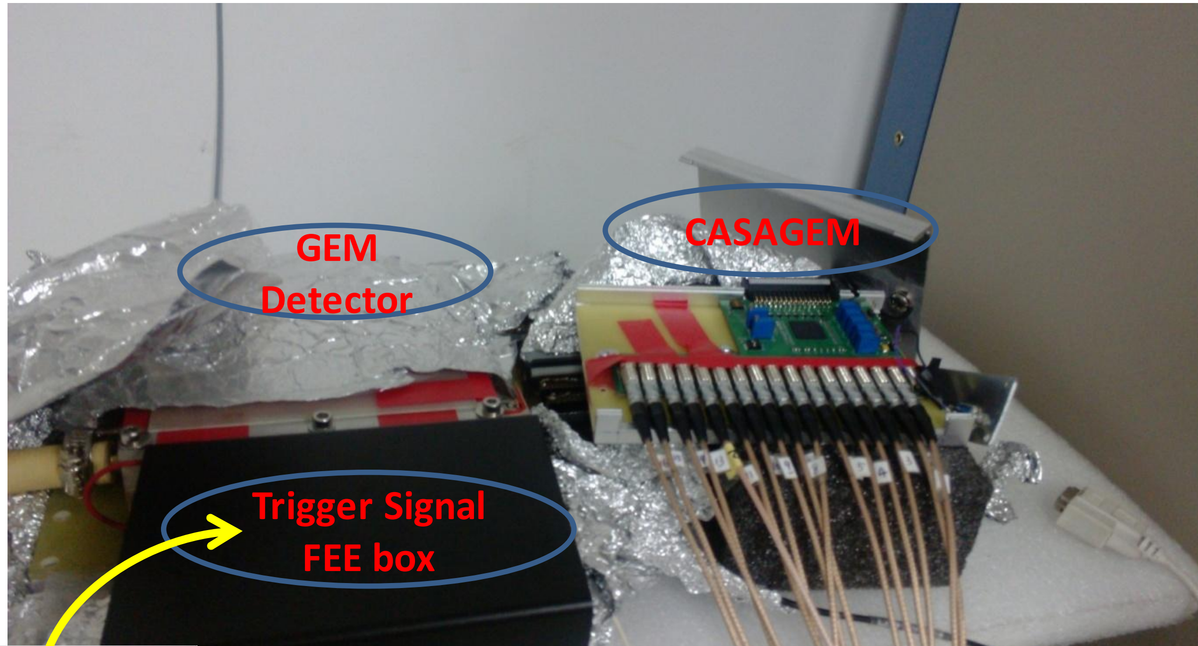
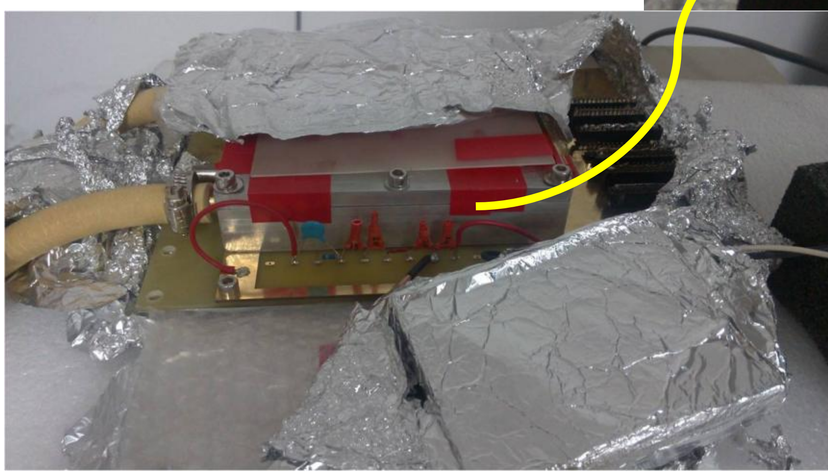
The set up of CASAGEM system

Trigger signal

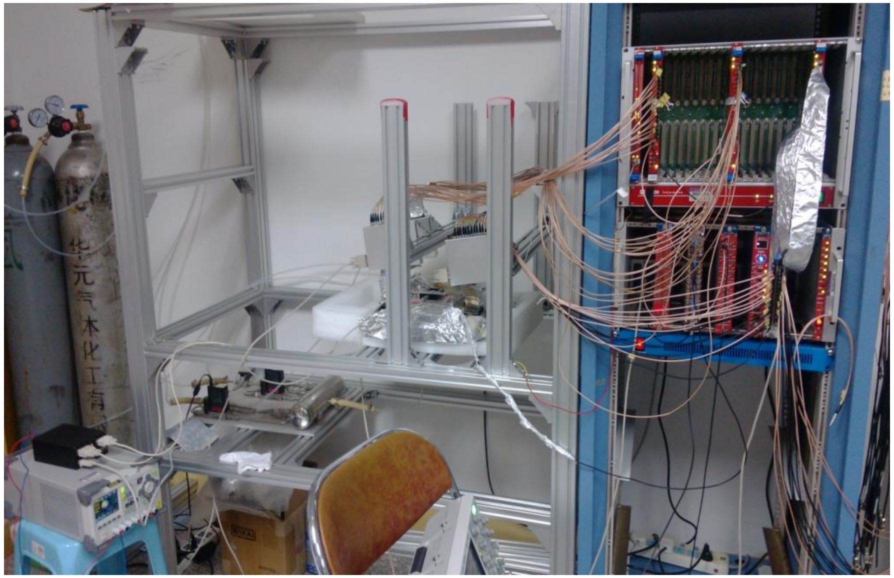
The trigger signal is from the last layer of the second foil

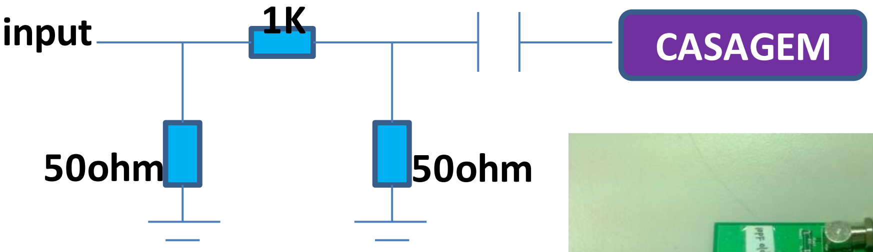




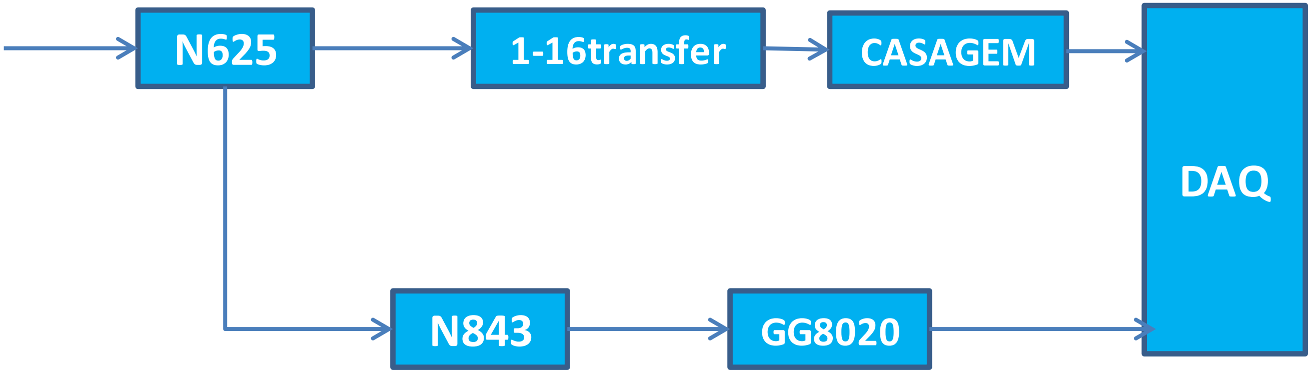
Test results of 2D GEM detector

64 channels Installation



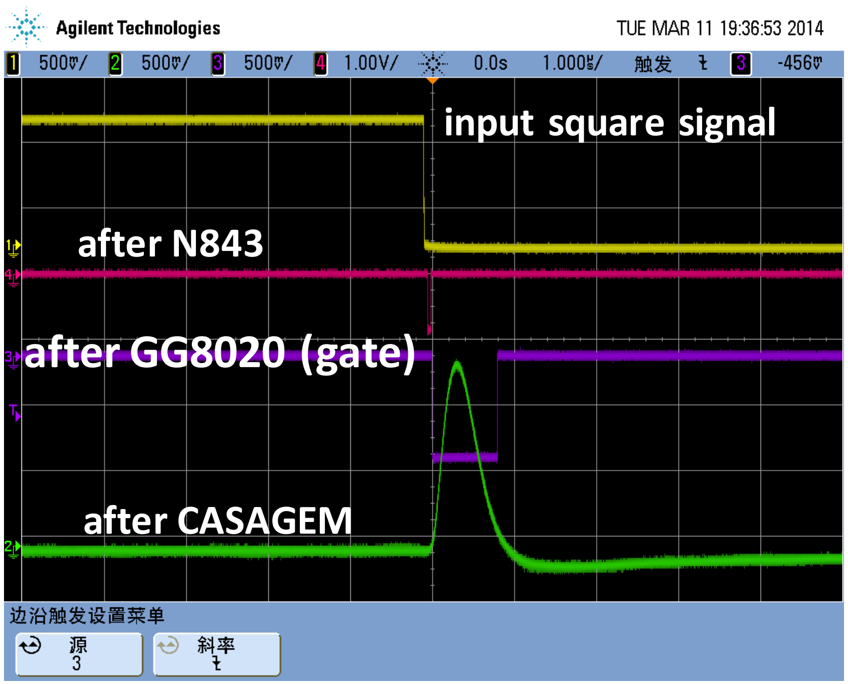


Signal transfer

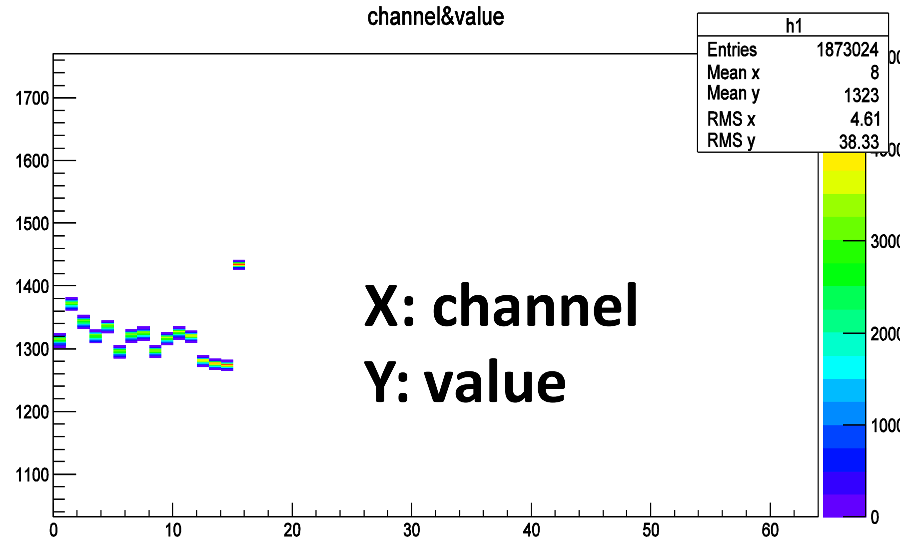


Calibration of the electronics

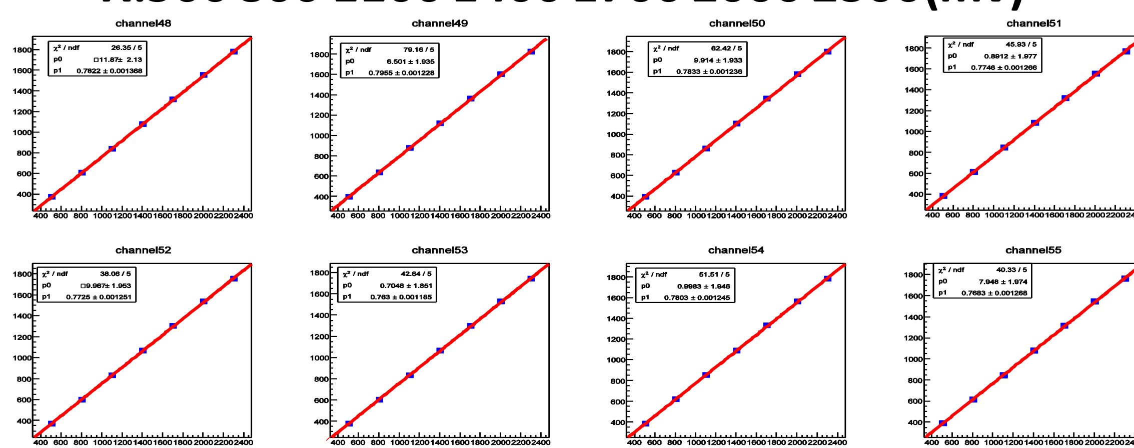
Test results of 2D GEM detector



Calibration of the electronics

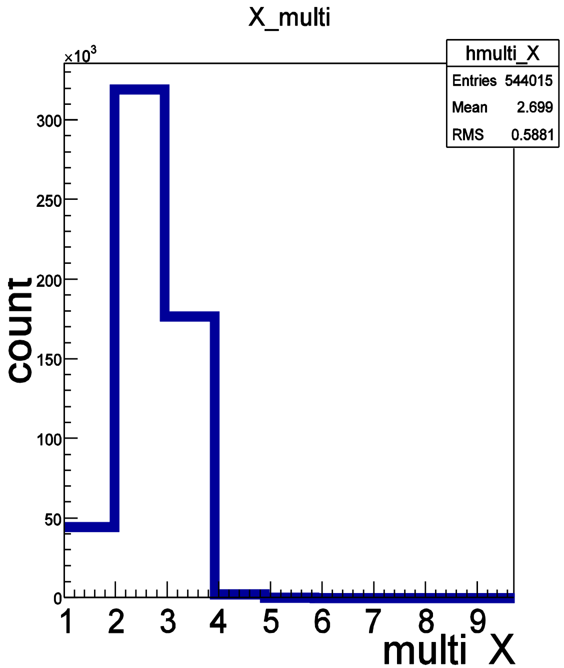


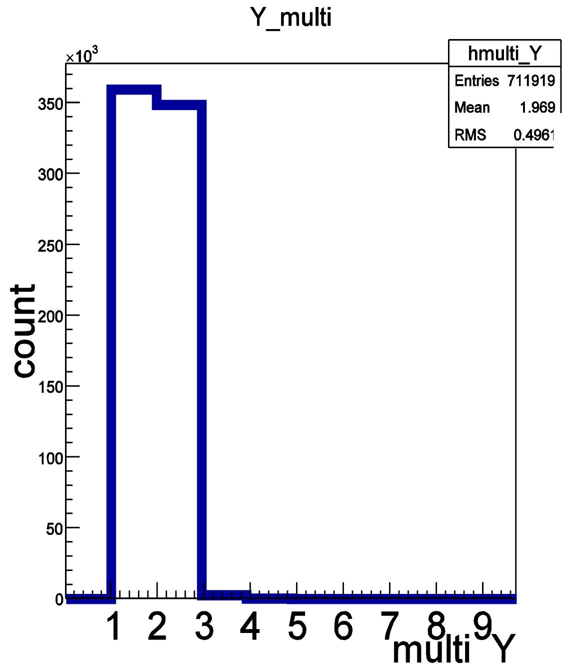
X:500 800 1100 1400 1700 2000 2300(mv)



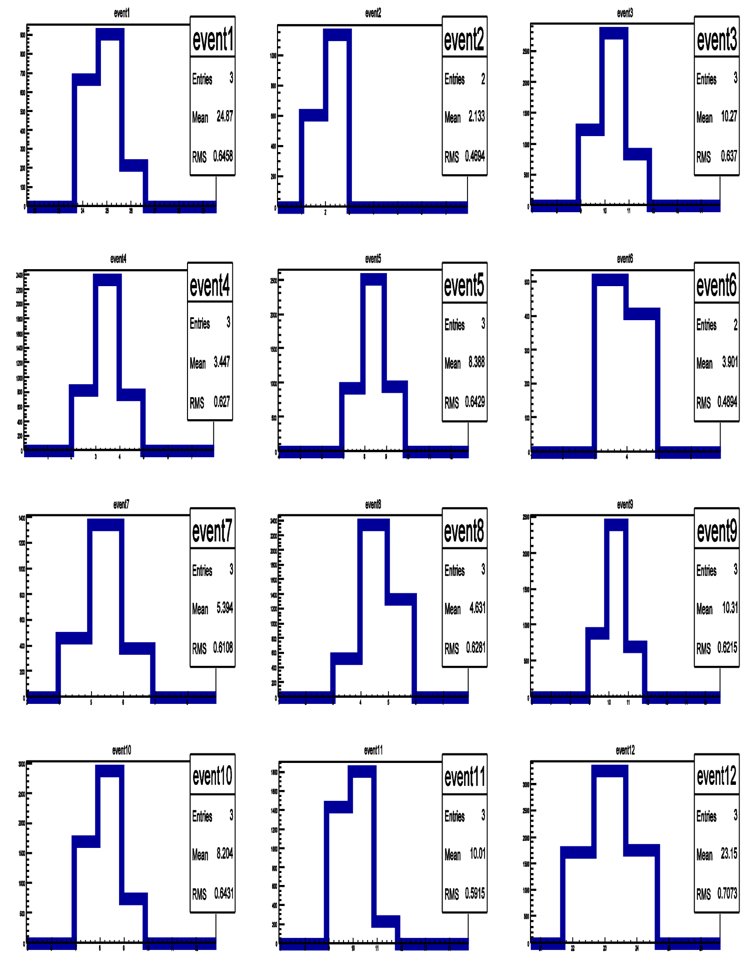
The calibration results of 8 channels, 64 in total.

Test results of 2D GEM detector





Cluster size of signal



The strip width in X direction is 446 μm, and the multiplicity is mainly 2.

The strip width in Y direction is 625μm, and the multiplicity is 1 and 2.

Event Display in X direction

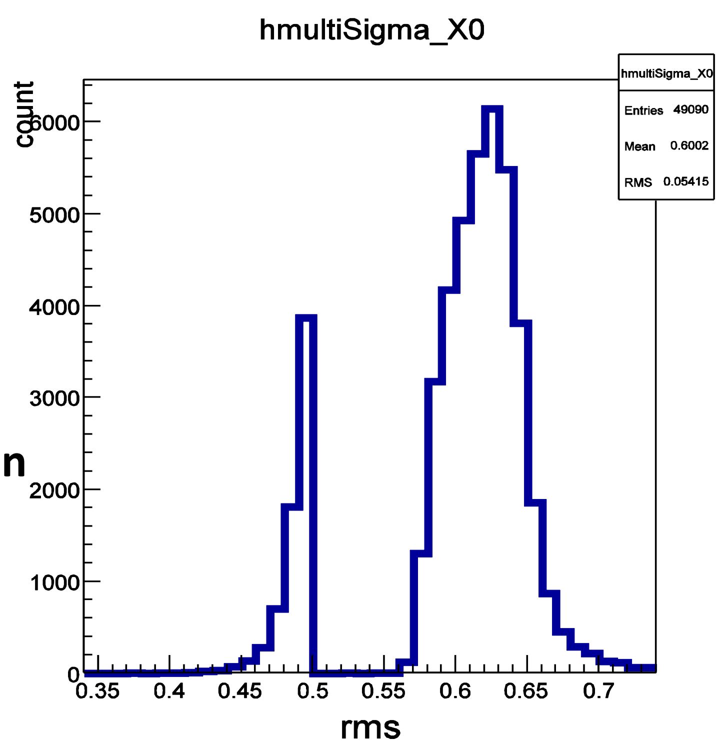
Test results of 2D GEM detector

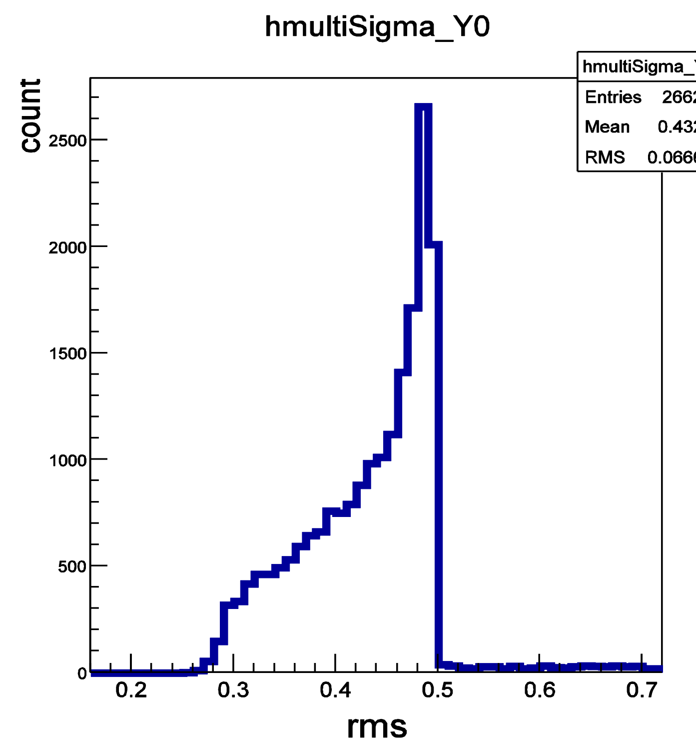
Second central moment

$$E[x^2] = \frac{\sum_{i=1}^{16} (x_i - \overline{x})^2 a_i}{\sum_{i=1}^{16} a_i}$$

x_i is the position of fired strip
a_i is the amplitude of signal
$\overline{x}$ is the position, calculated from centroid

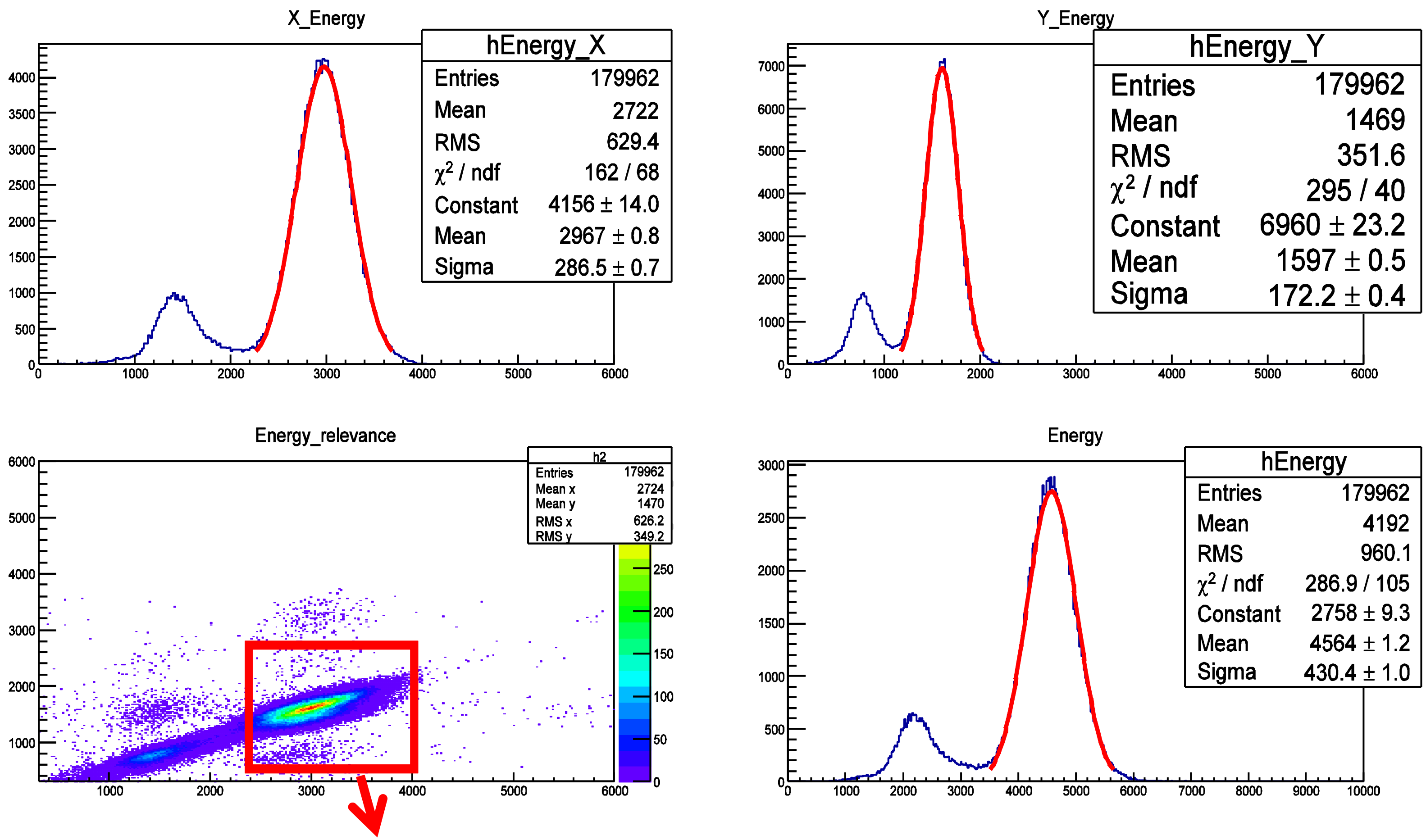
The variance distribution
In X and Y direction.





Test results of 2D GEM detector

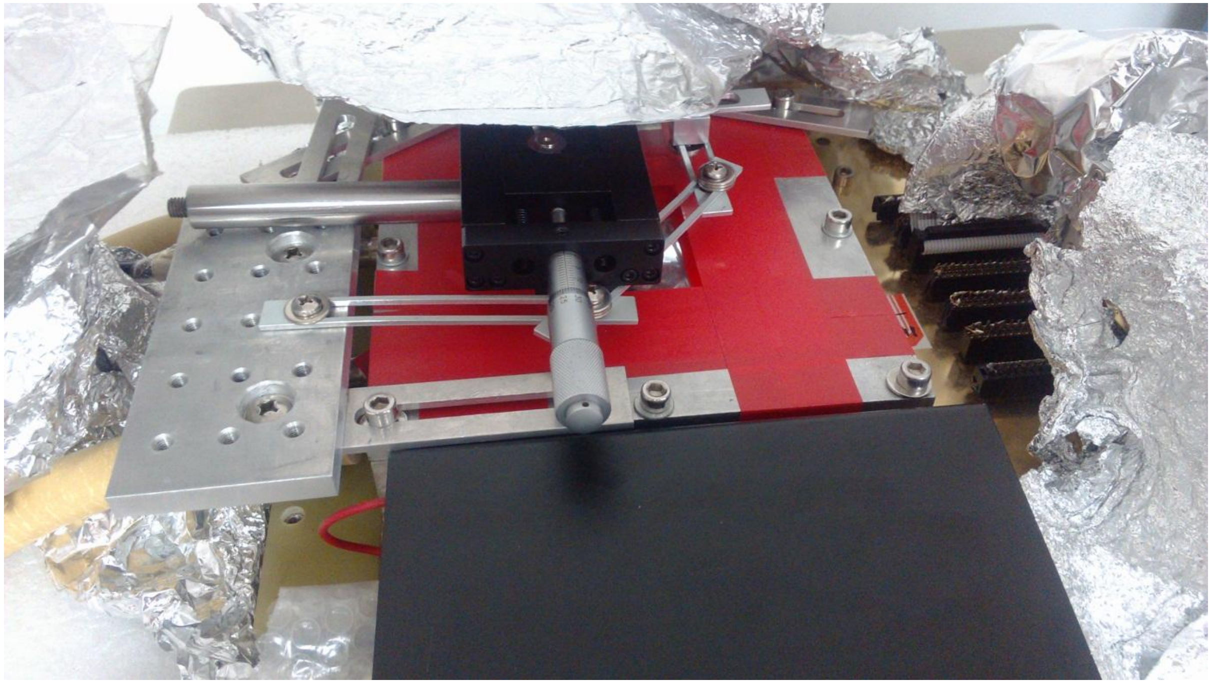
Energy resolution



The correlation between Energy of X direction and that of Y.

X: 22%　　Y:25%　　total: 22%

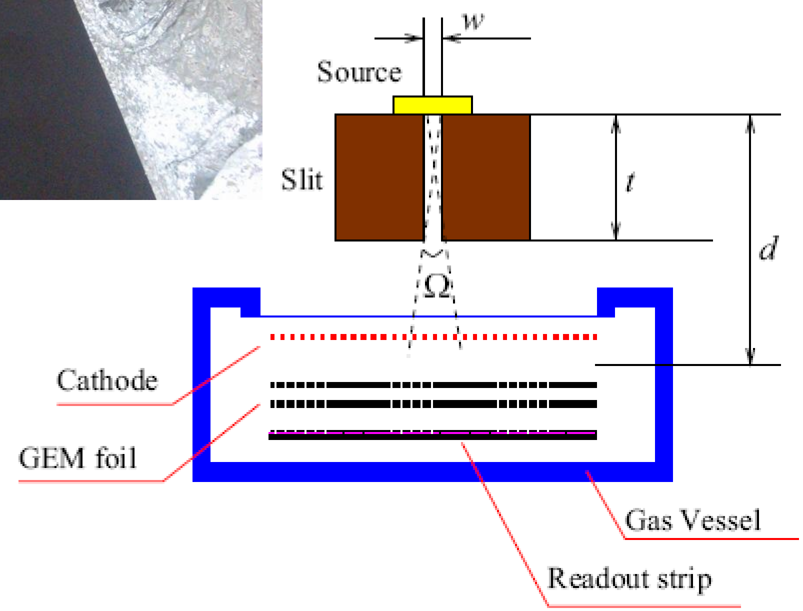
Test results of 2D GEM detector



Spatial resolution

method description

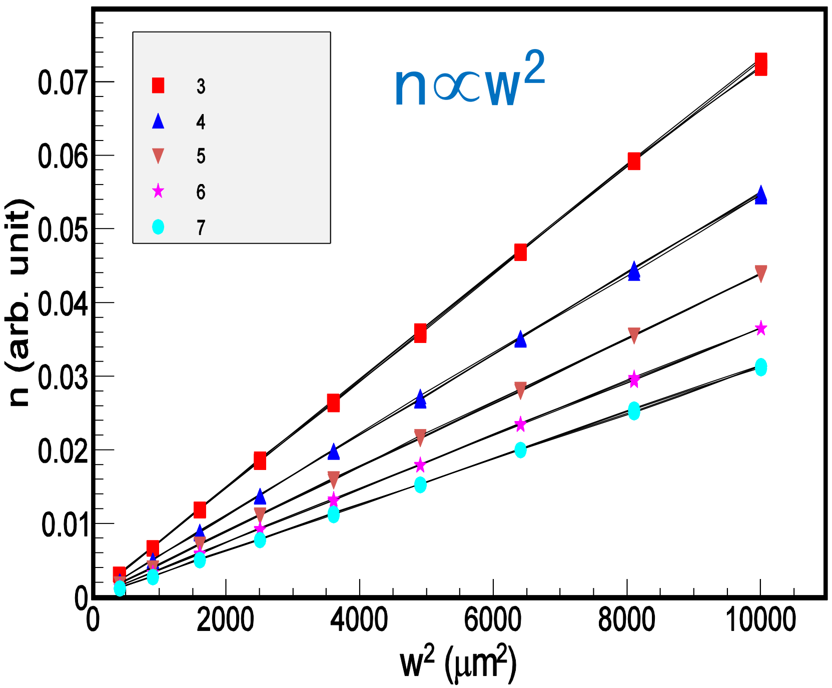
The slit is used as a collimator



Schematic diagram of the slit system

Test results of 2D GEM detector

Spatial resolution
method description



$$\sigma^2_{tot} = \sigma^2_{GEM} + c_1\sigma^2_{Geometry}$$

when $w \sim \sigma_{GEM}$

$$\sigma_{Geometry} = c_2 w$$

$$\sigma^2_{tot} = \sigma^2_{GEM} + c_0 w^2$$

$$n = \rho w \phi \Omega \eta / 4\pi$$

$$n = c_2 w^2$$ **n is counting rate**

$$\sigma^2_{tot} = \sigma^2_{GEM} + c_0 n$$

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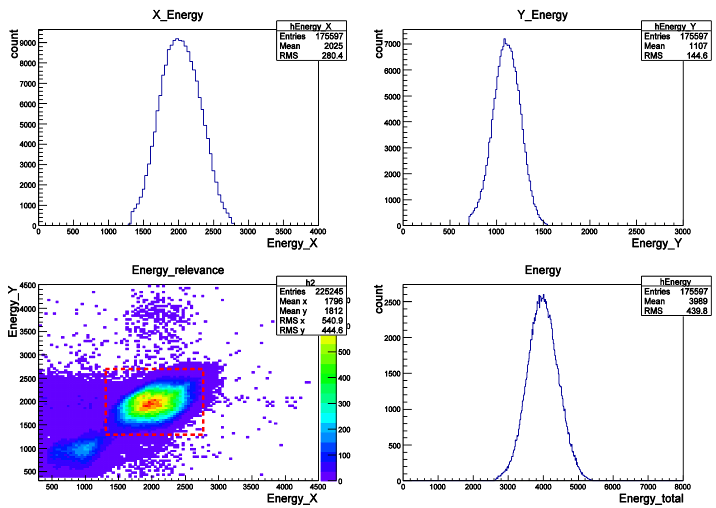
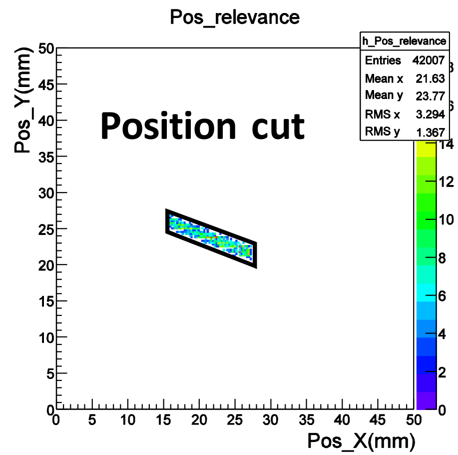
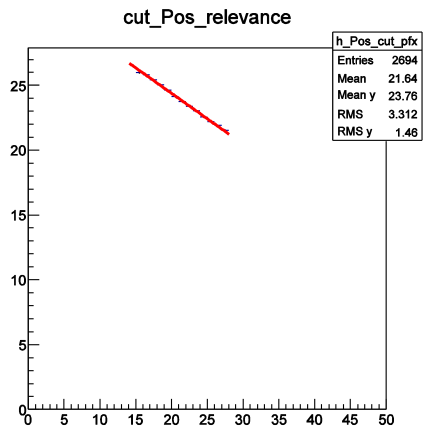
Test results of 2D GEM detector

spatial resolution

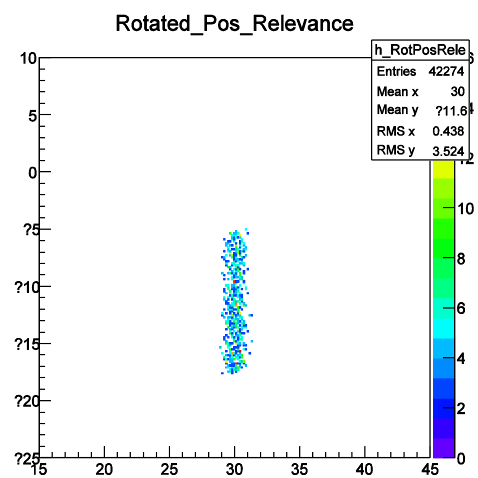


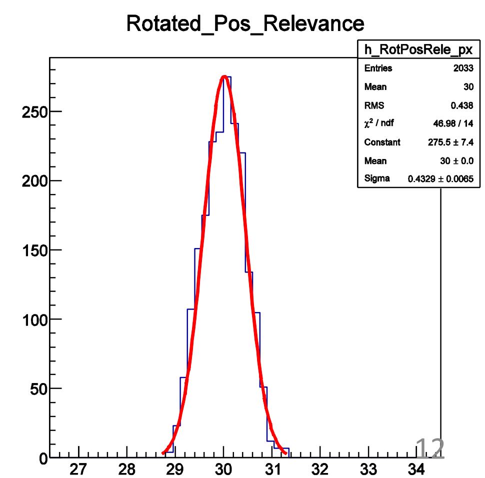
Energy cut





rotate

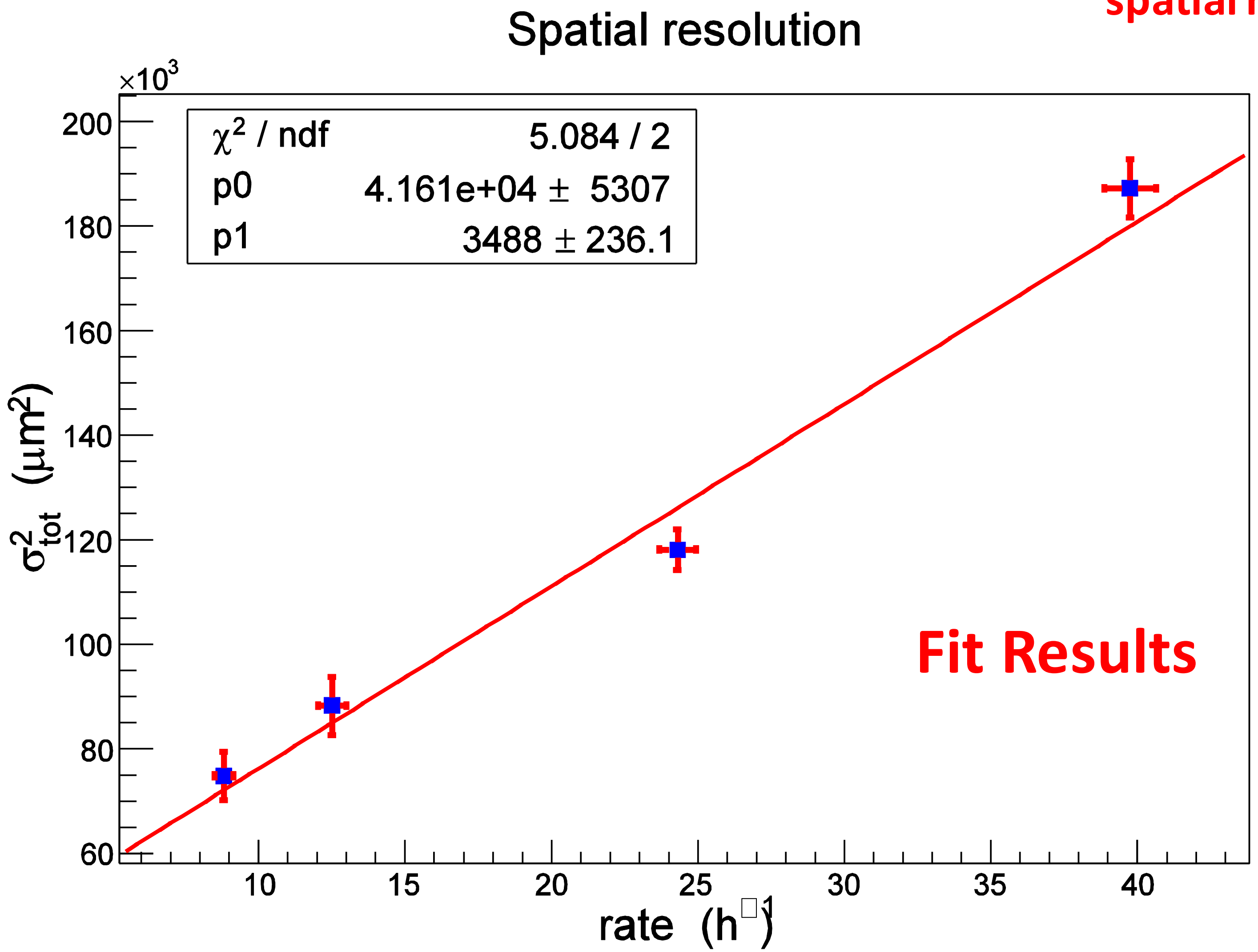




In this way, we can get the spatial Resolution for a given width of the slit.

Test results of 2D GEM detector

spatial resolution

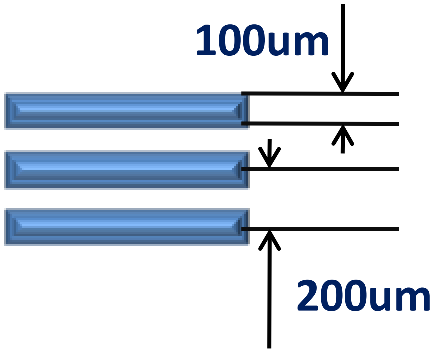


204±13(μm)

$$\sigma^2_{tot} = \sigma^2_{GEM} + c_0 n$$

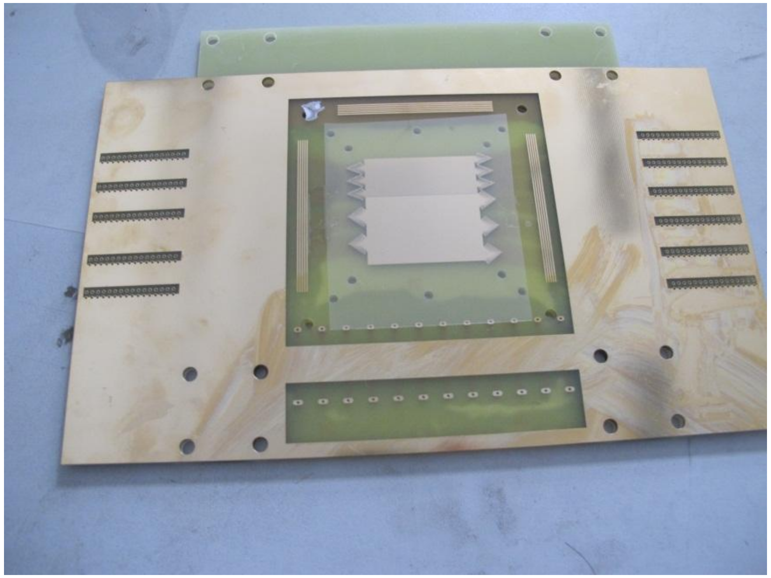
Test results of 2D GEM detector

spatial resolution

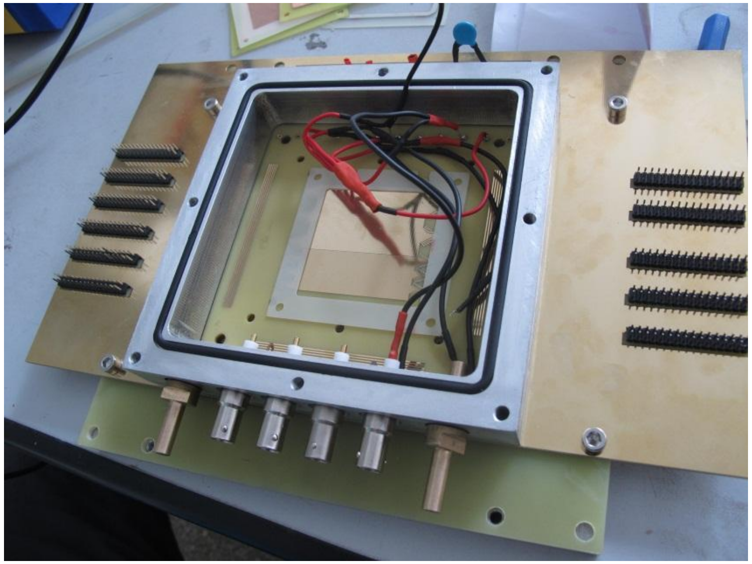


strip width(μm)	δ_{exp}(μm)	δ_{theo}(μm)
200	56±15	58
X:446 Y:625	204±13	221
446	159±22	129

$$\delta_{theo} = \frac{w}{\sqrt{12}}$$



Readout of 1D GEM(200μm)

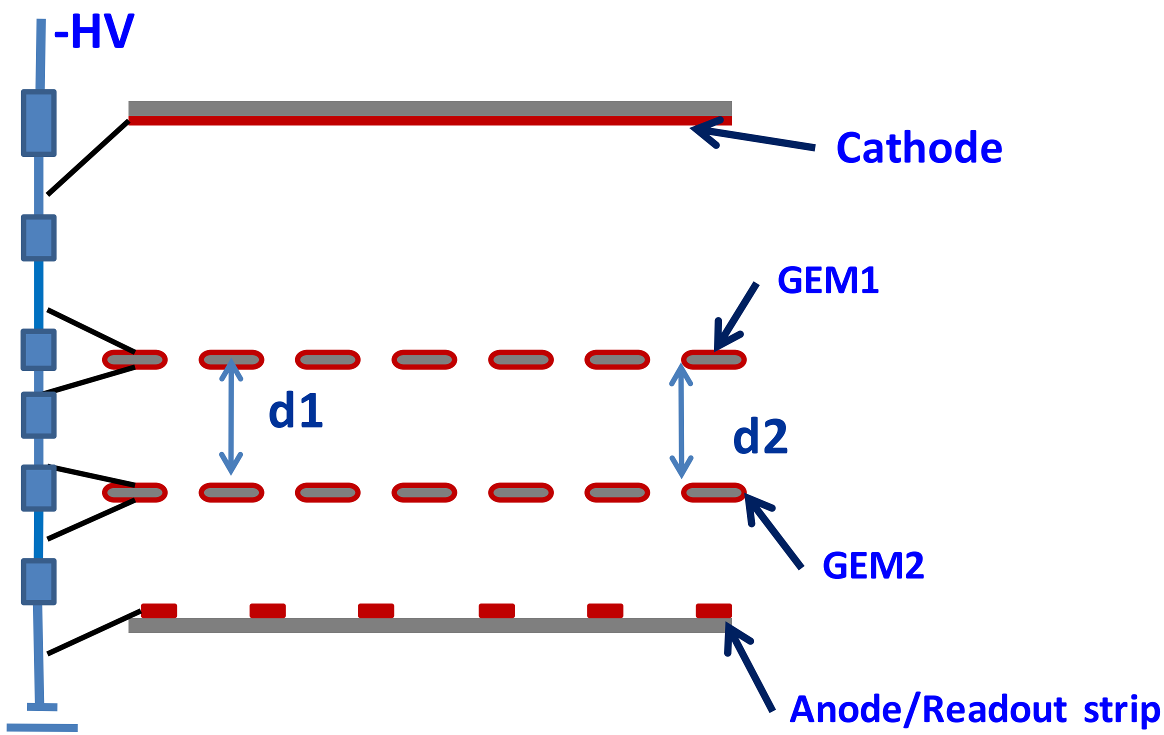


1D GEM detector

The effect of non-uniform inter-foil distance

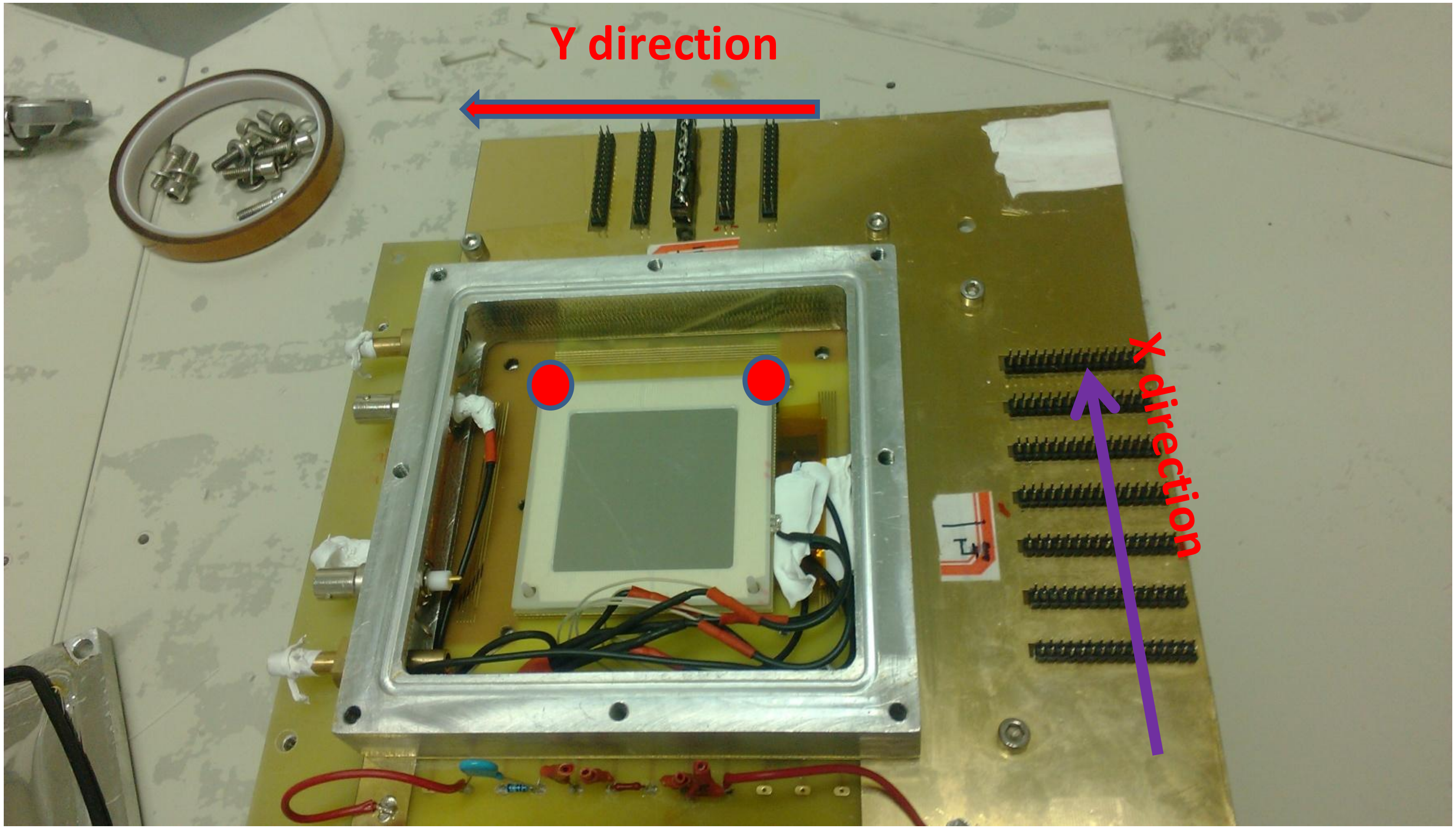
motivation

For large foil, the distance is hard to be completely homogeneous, particularly when it is running in high current in B field.



The effect of non-uniform inter-foil distance

Foil distance changed



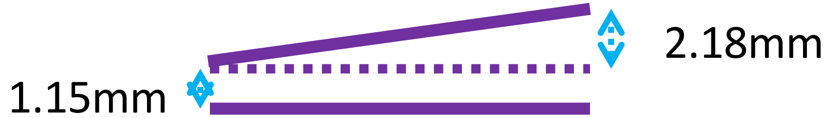
● : stands for the paddle

We have disassembled the 2D GEM and put a paddle between the two foils in one side along X.

The effect of non-uniform inter-foil distance

Two setups

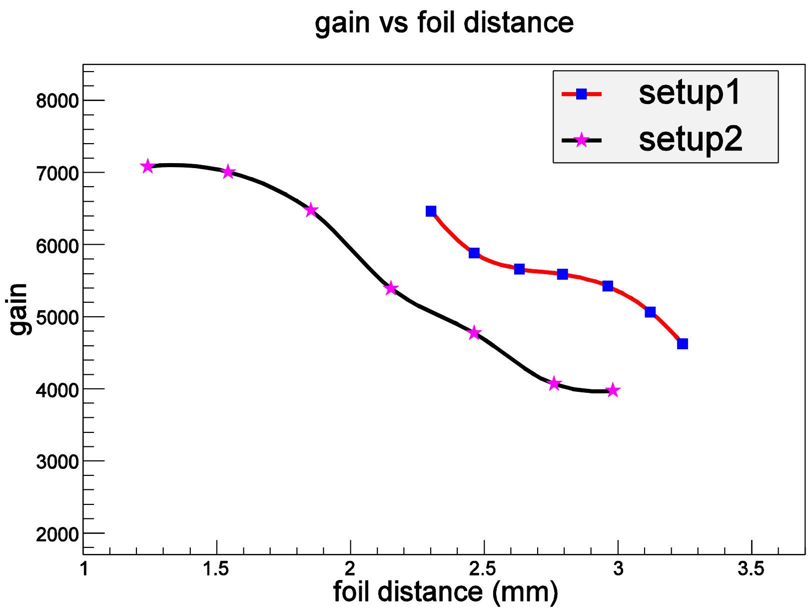
Scheme of setup1



Scheme of setup2

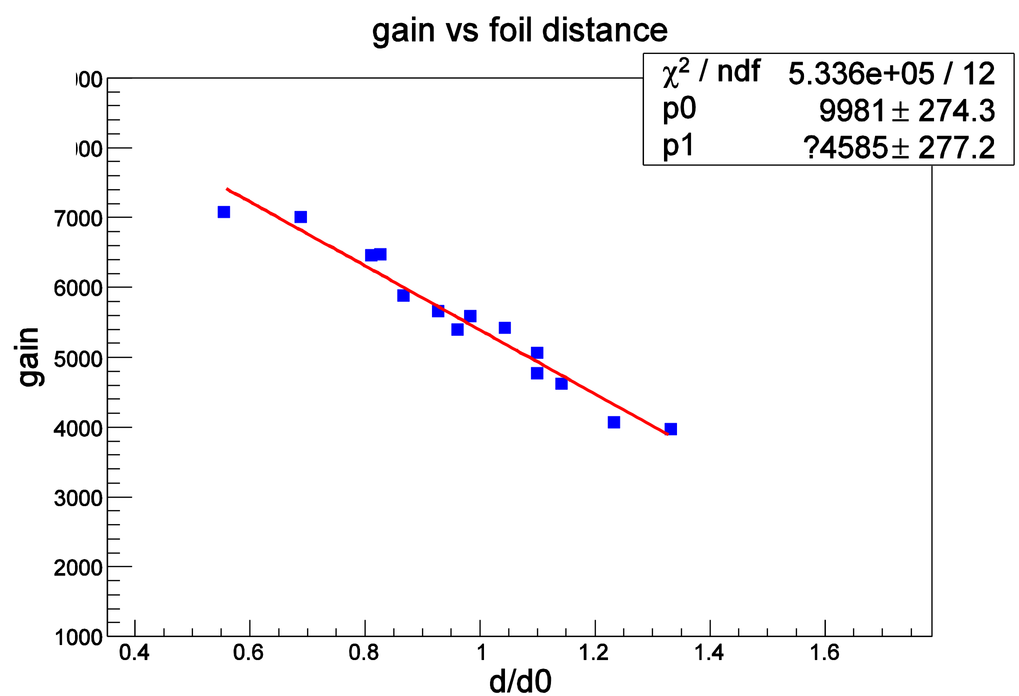
A movable optical platform, prepared for the large GEM.

The effect of non-uniform inter-foil distance

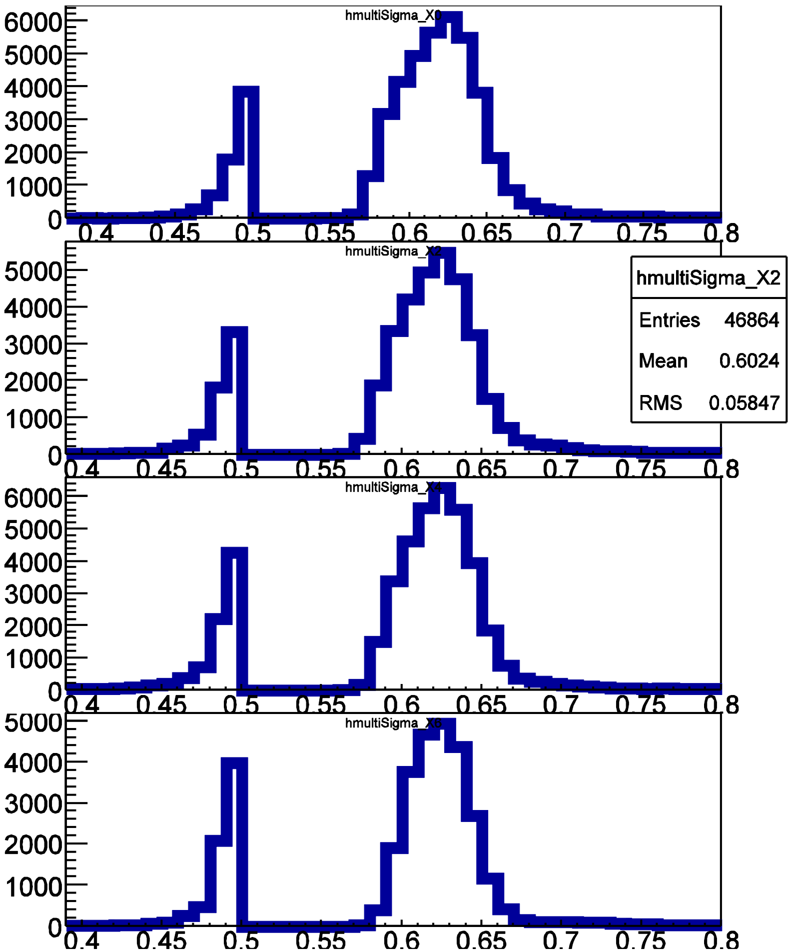


Gain vs distance

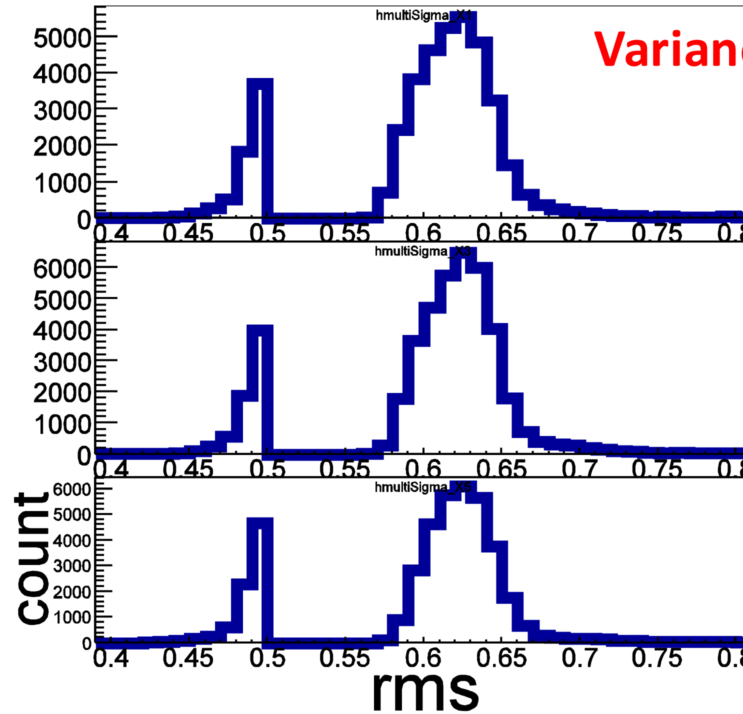
The gain decreases with relative changes of the foil distance.



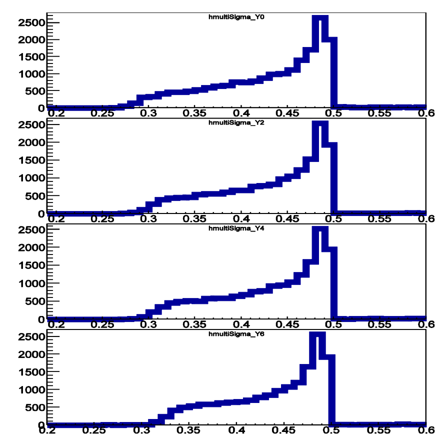
The effect of non-uniform inter-foil distance

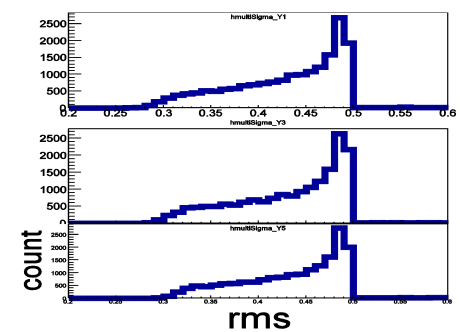


Variance vs distance



different distances

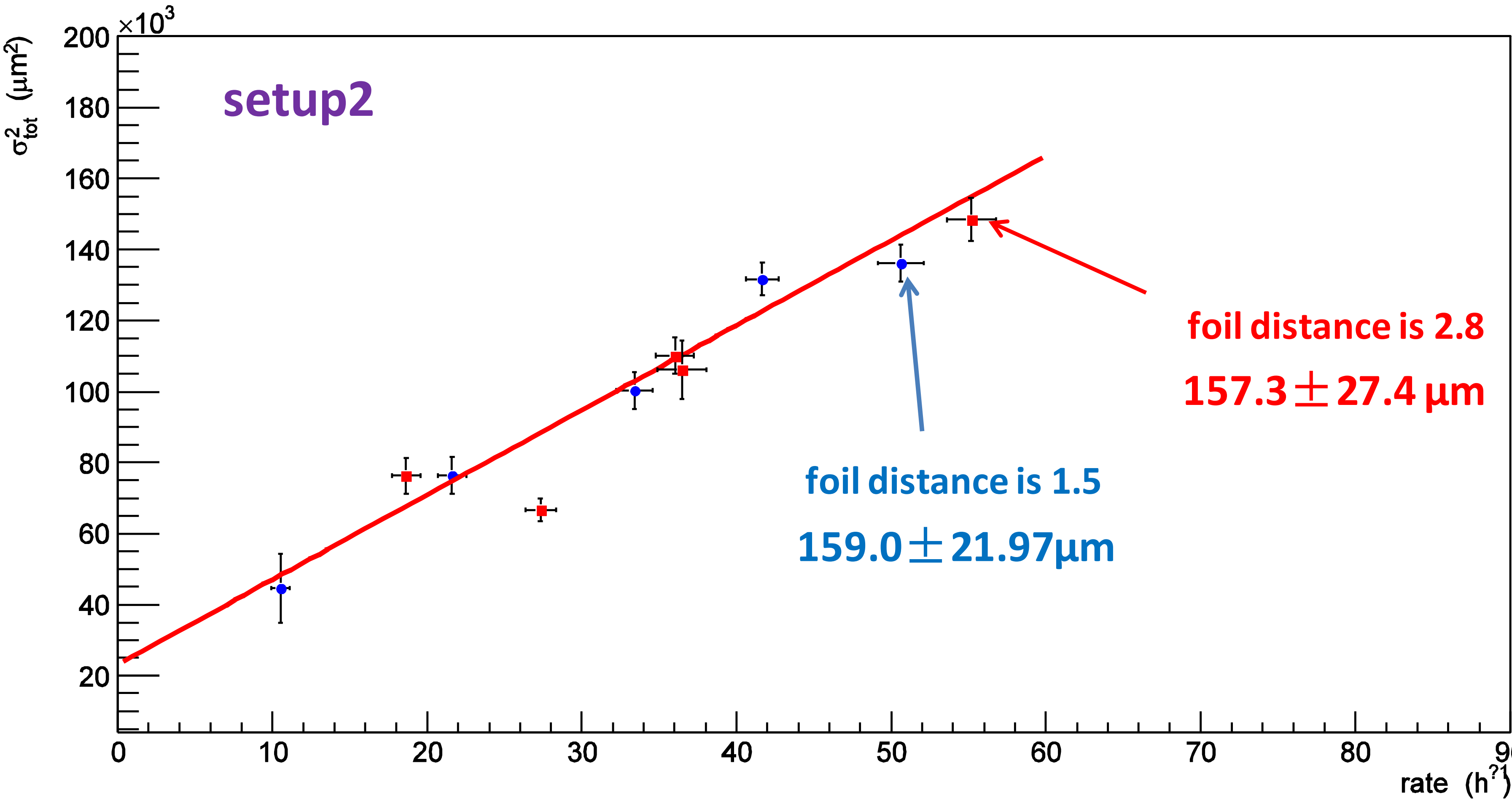




We can see that the distributions of the cluster size are almost the same for different foil distances.

The effect of non-uniform inter-foil distance

spatial resolution vs distance

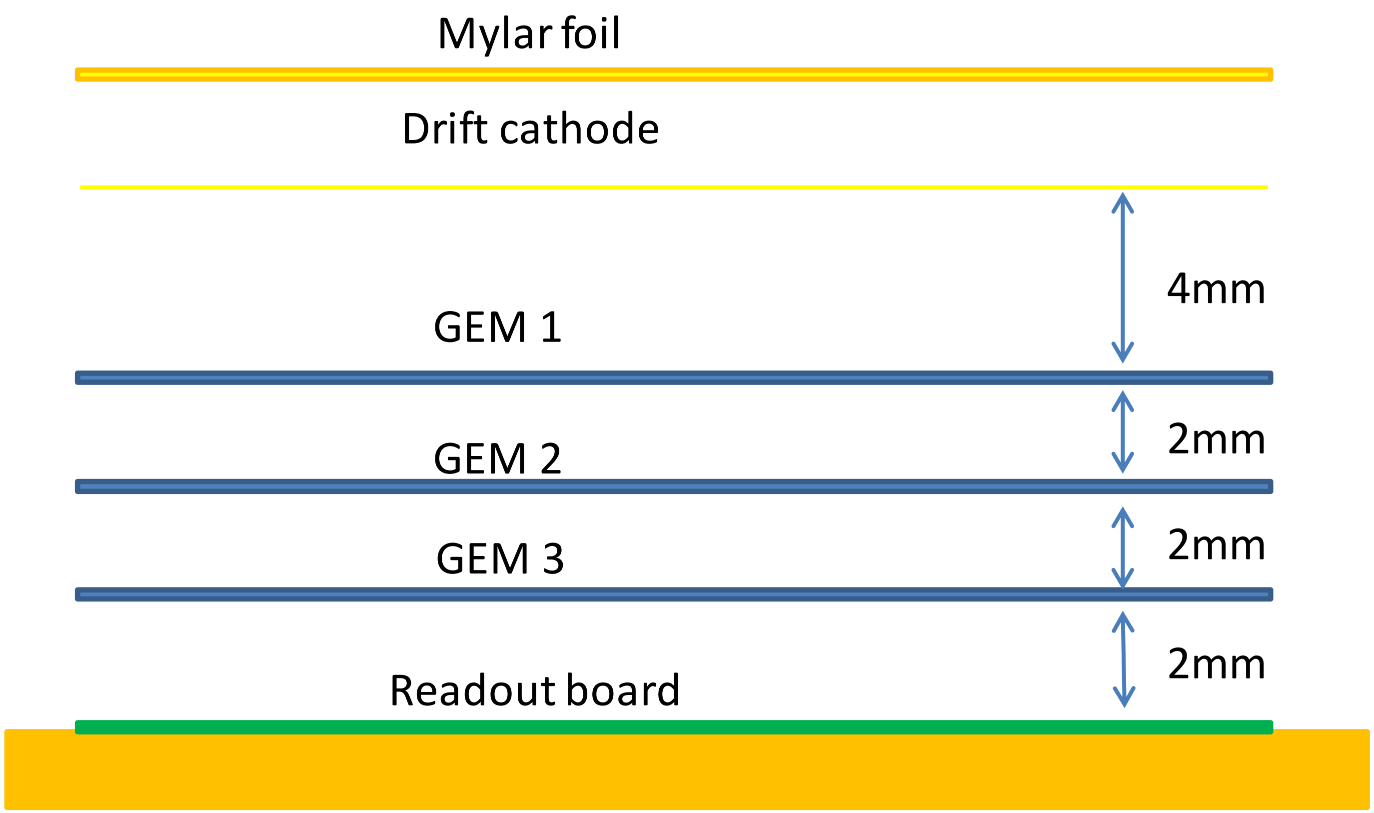


It is shown that the spatial resolution changed very little for different foil distances, this is reasonable considering that the cluster size distributions are almost the same with different distances.

Status of large area GEM detector

introduction

Scheme of the triple GEM 45cm*45cm



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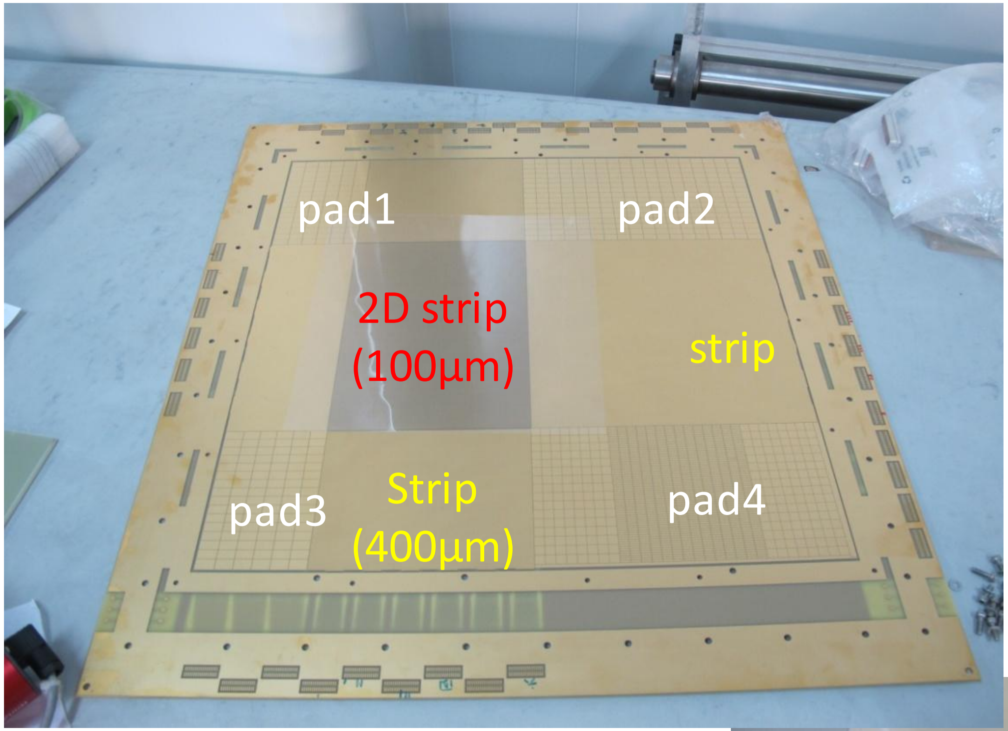
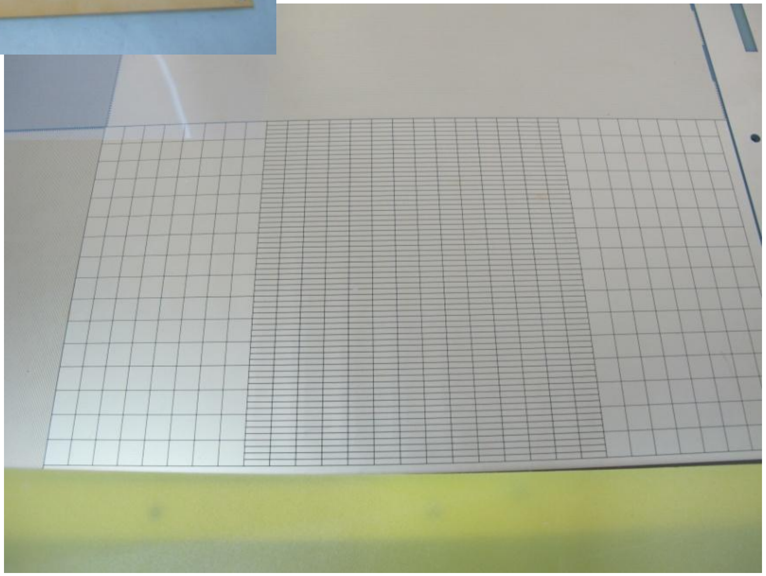
Status of large area GEM detector

Readout Board

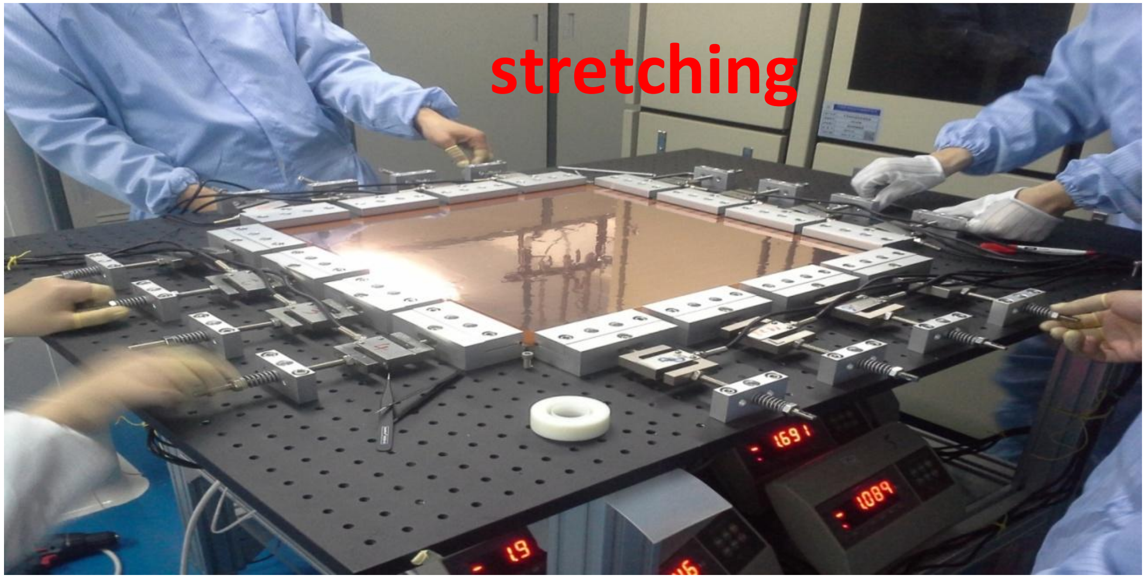


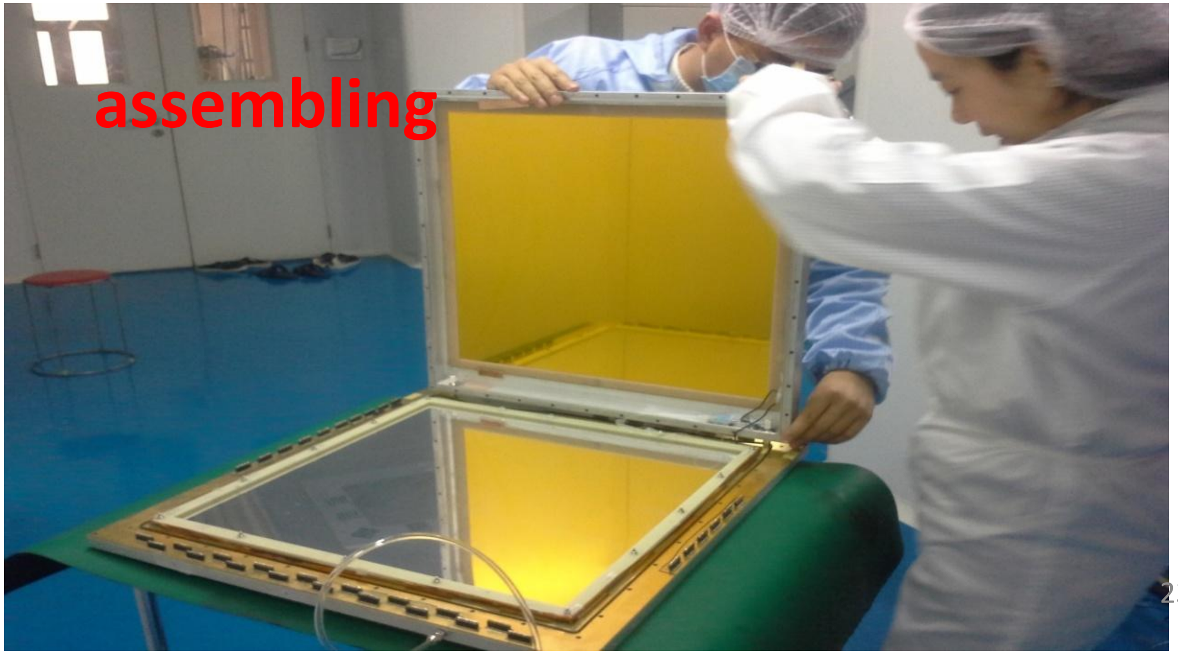
Readout Board:
Pad and strip



Pad:
2mm*7mm
7mm*7mm
7.5mm*12.5mm

Status of large area GEM detector





Collaborate with Prof. Limin Duan and his group, IMP

Summary and Plan

Summary

1) 基于CASAGEM的GEM探测器测试系统正常工作。目前有320路电子学。

2) 5cm*5cm 2维GEM探测器的能量分辨为22%，与商用电子学所测结果吻合，在~45°方向上的位置分辨为204±13(μm)。经过多组测量得出结论：丝读出GEM的位置分辨为：$\frac{w}{\sqrt{12}}$。

3) GEM 探测器的增益随膜间距的相对变化呈反线性关系。位置分辨随膜间距改变无明显变化。

4) 45cm*45cm 3层GEM探测器正在组装。

Summary and Plan

Short term plan

1. Carry on some tests on the large area GEM detector when it works.
2. Improve the online DAQ system.

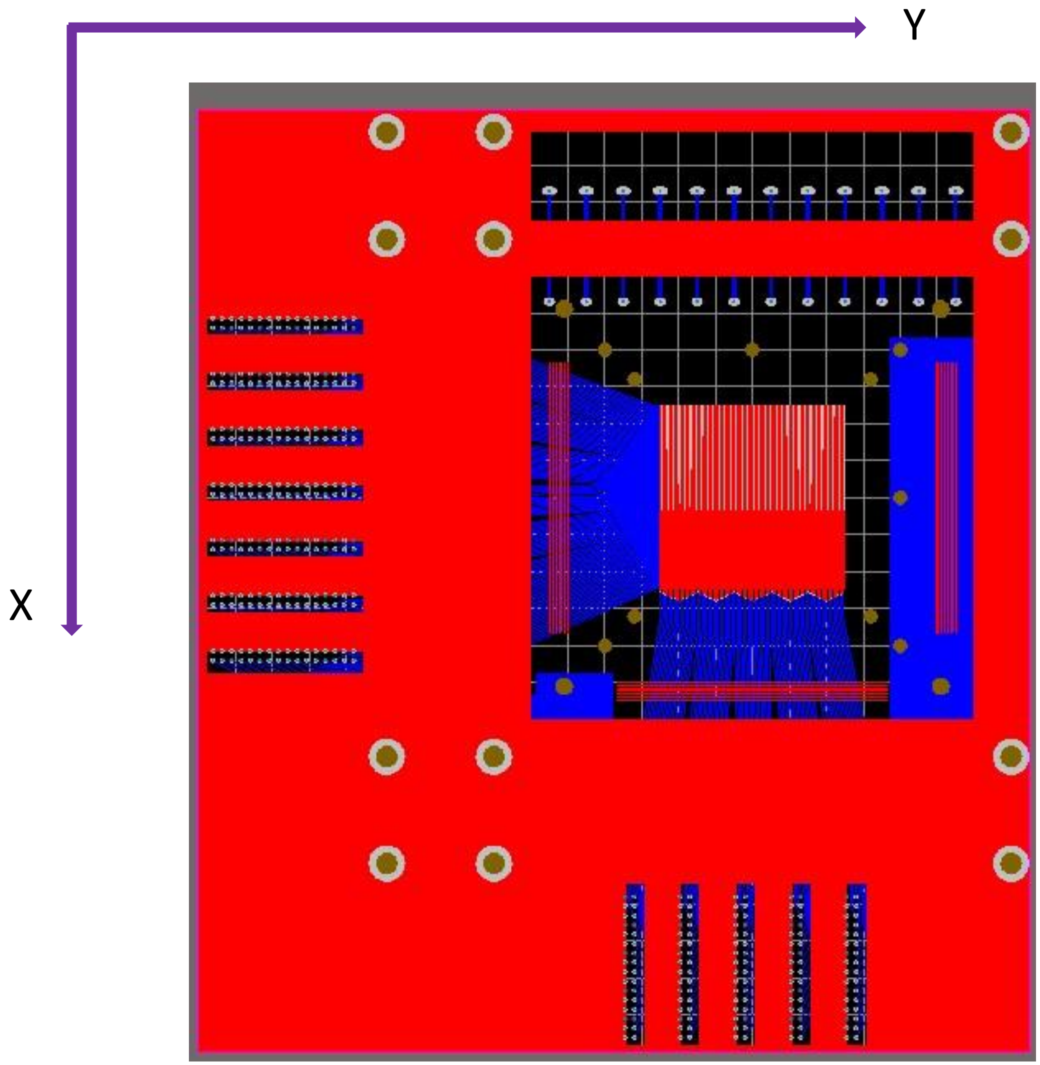
Thank you!

Back up

Back up

Spatial Resolution in estimation

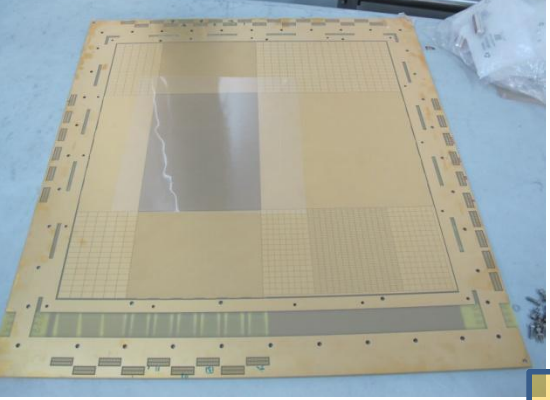
(when Multi = 2)



$$\delta_x = \frac{50000}{16 \times 7} \div \sqrt{12} = 129\mu m$$

$$\delta_y = \frac{50000}{16 \times 5} \div \sqrt{12} = 180\mu m$$

$$\delta = \sqrt{\delta_x{}^2 + \delta_y{}^2} = 221\mu m$$



Back up