

# ***GEM R&D Activity in USTC***

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# Outline



- ❖ ***The GEM Gain Calibration***
- ❖ ***The 30cm × 30cm GEM of USTC***

## ❖ *The GEM Gain Calibration*

- 1. Gain calibration system setup*
- 2. The effect of the cover & drift electrode*
- 3. The charging up effect*

- ◆ This work was done in CMS & RD51*
- ◆ 3 are still not finished yet*



# Effective gas gain calculation

Gain calibration system setup

$$G_{eff} = \frac{I}{N \times R \times 1.6 \times 10^{-19}}$$

Here:

$G_{eff}$  is the effective gas gain of the detector;

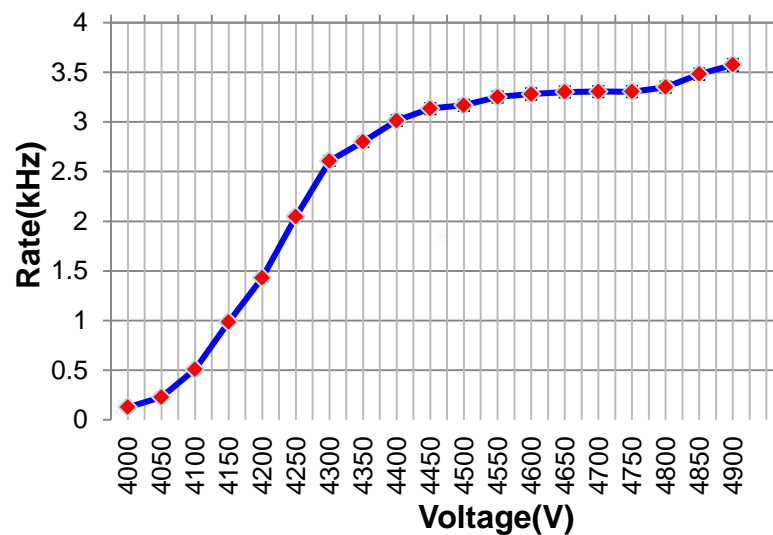
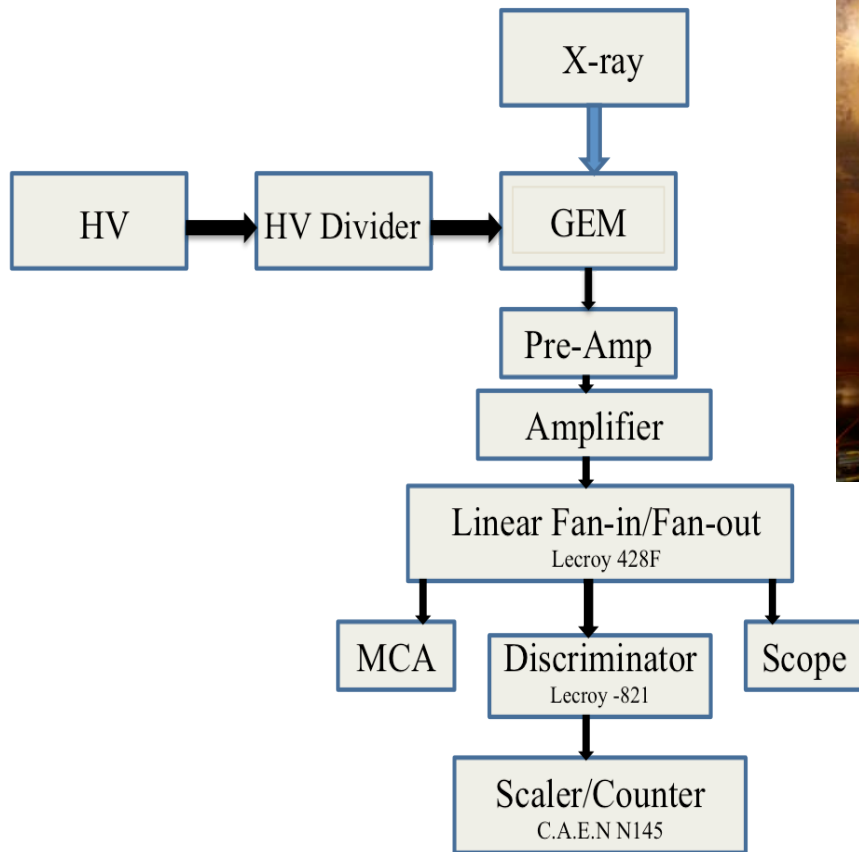
$I$  is the output current of the detector;

$R$  is the rate of the source(copper X-ray);

$N$  is the number of primary electrons released by each photon.

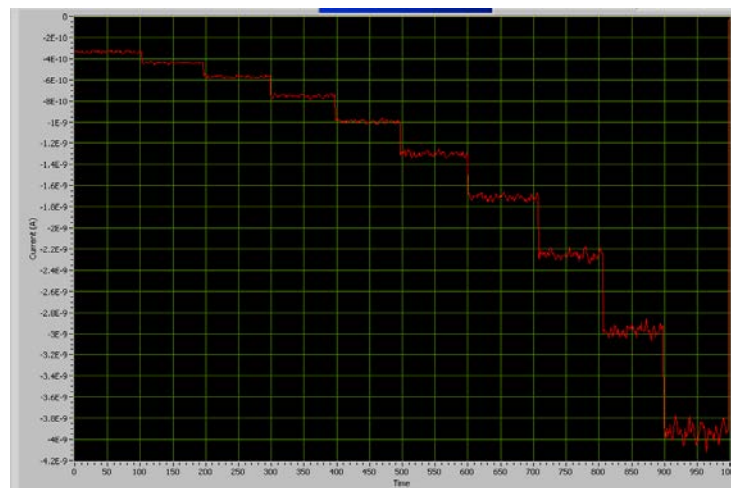
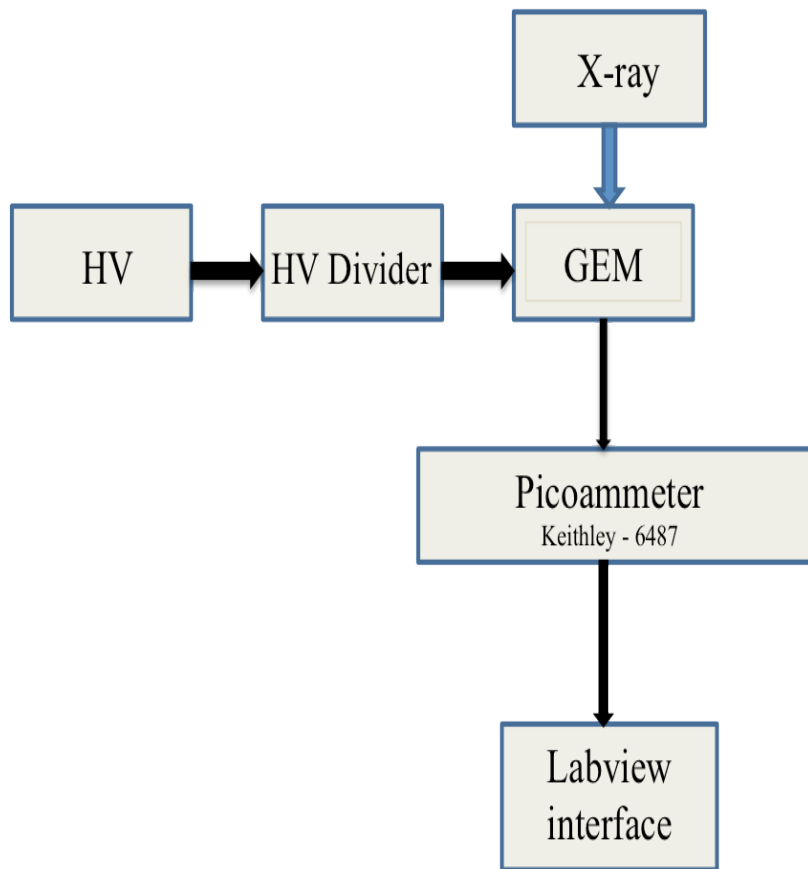
# The system setup for counting

## Gain calibration system setup



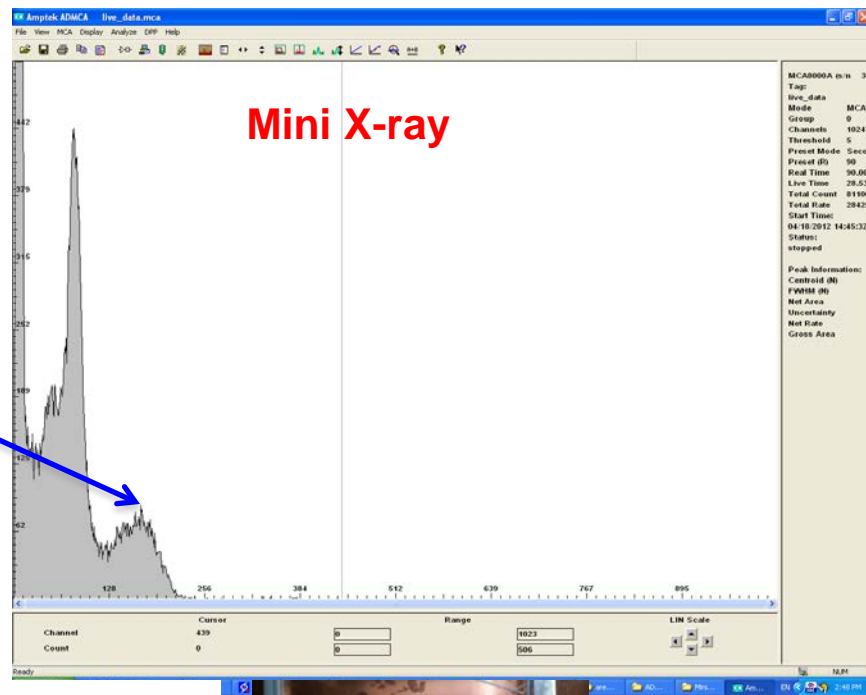
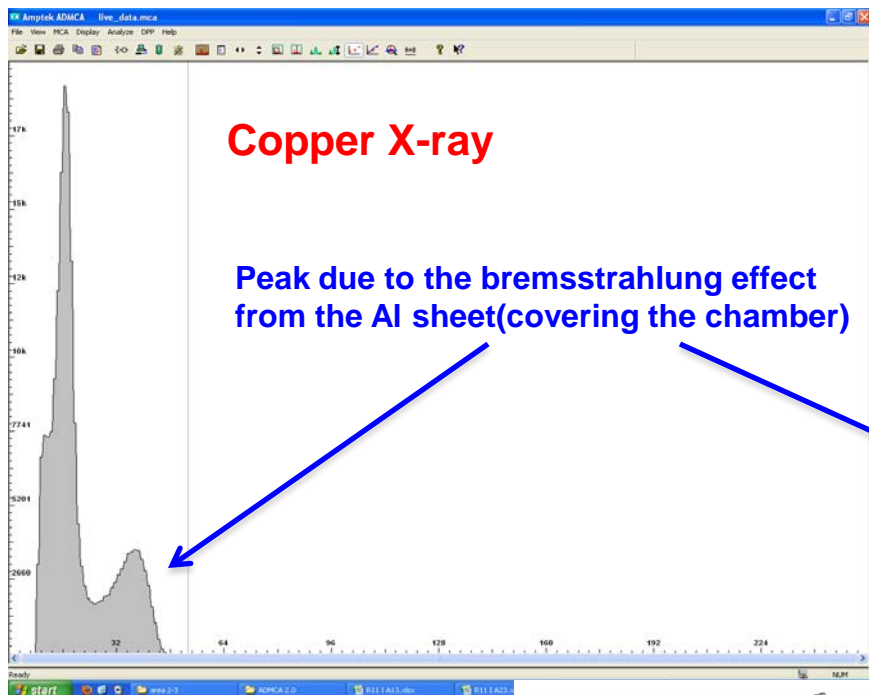
# The system setup for current measurement

## Gain calibration system setup

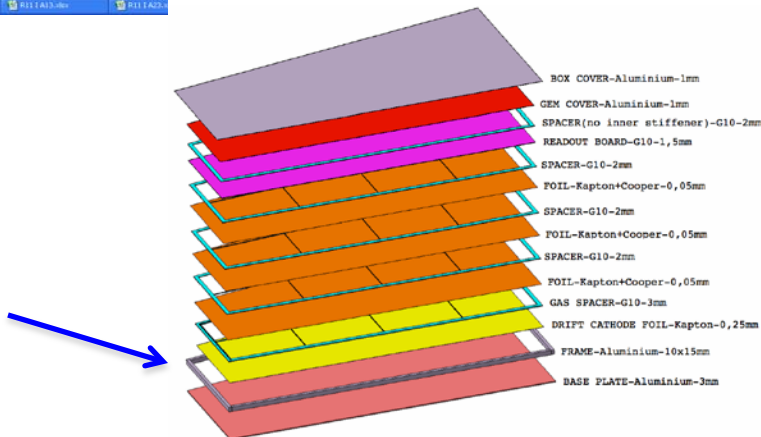


# The bremsstrahlung effect caused by the cover

## The effect of the cover & drift electrode

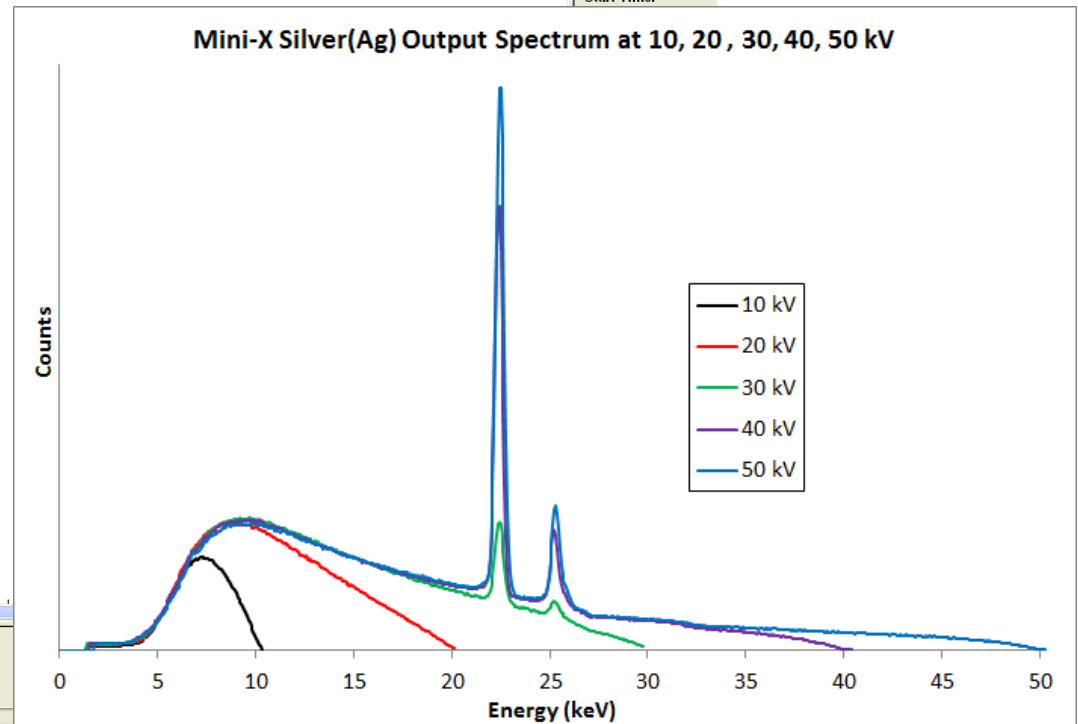
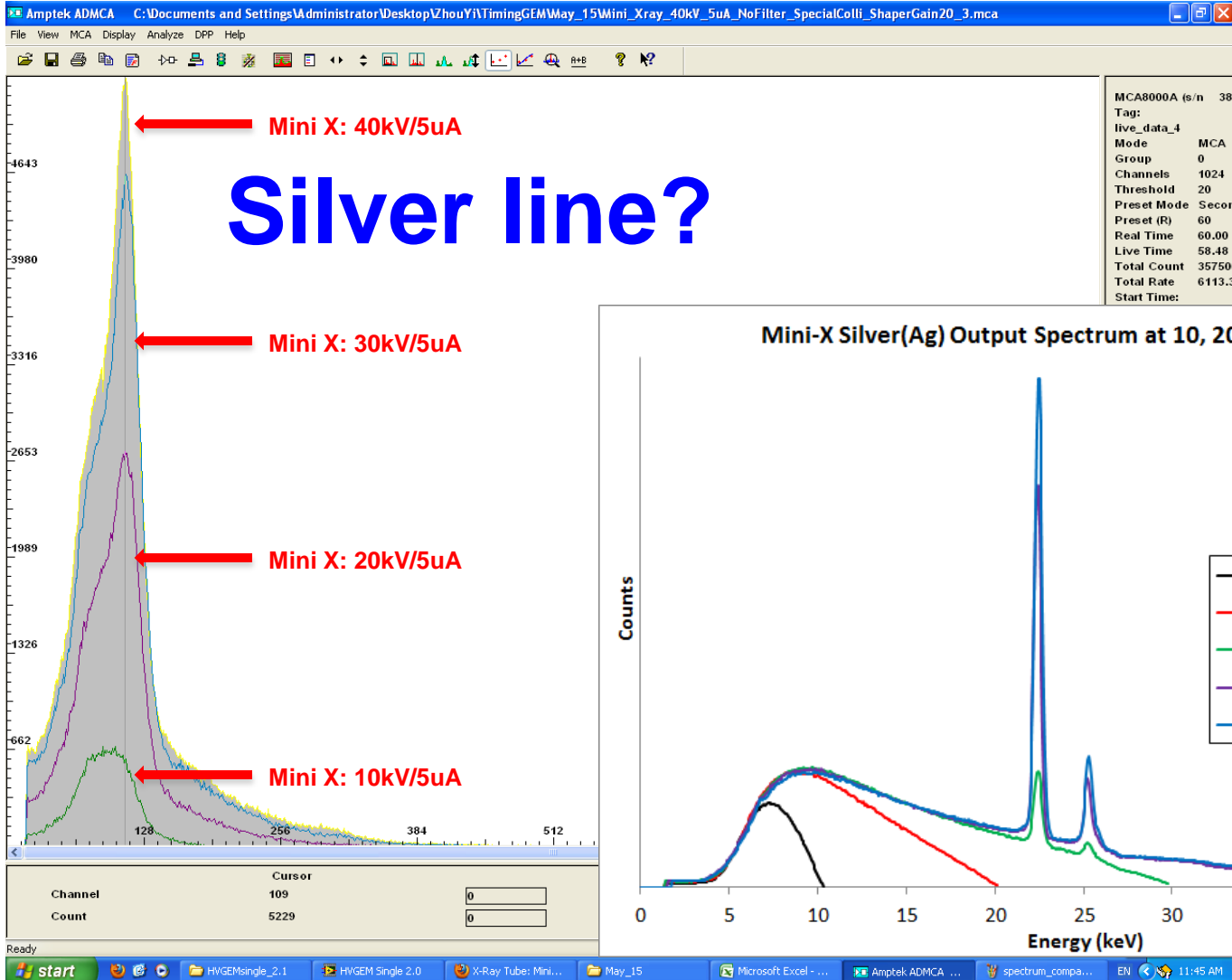


3mm Al sheet



# Energy transfer caused by the drift electrode

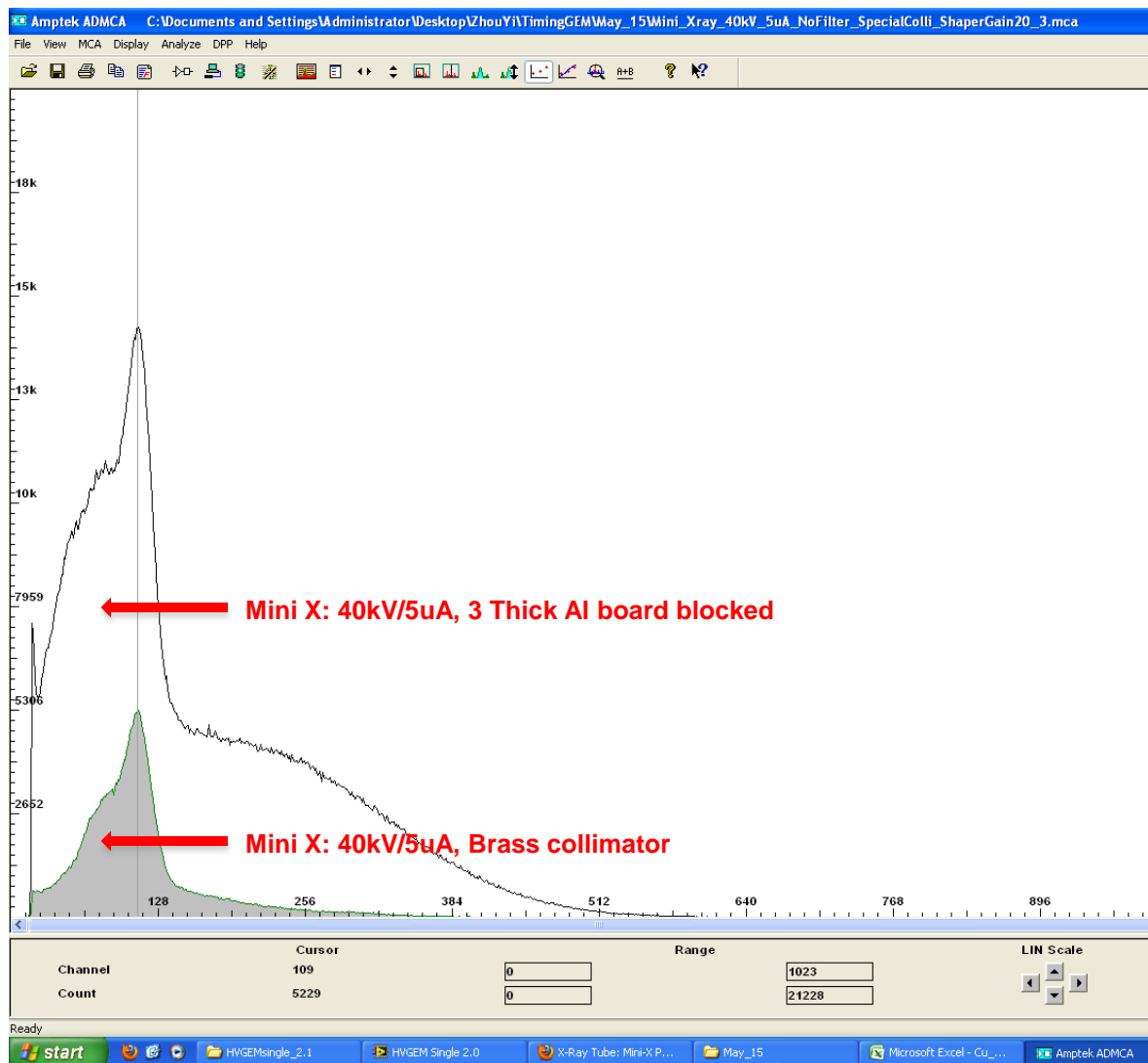
## The effect of the cover & drift electrode





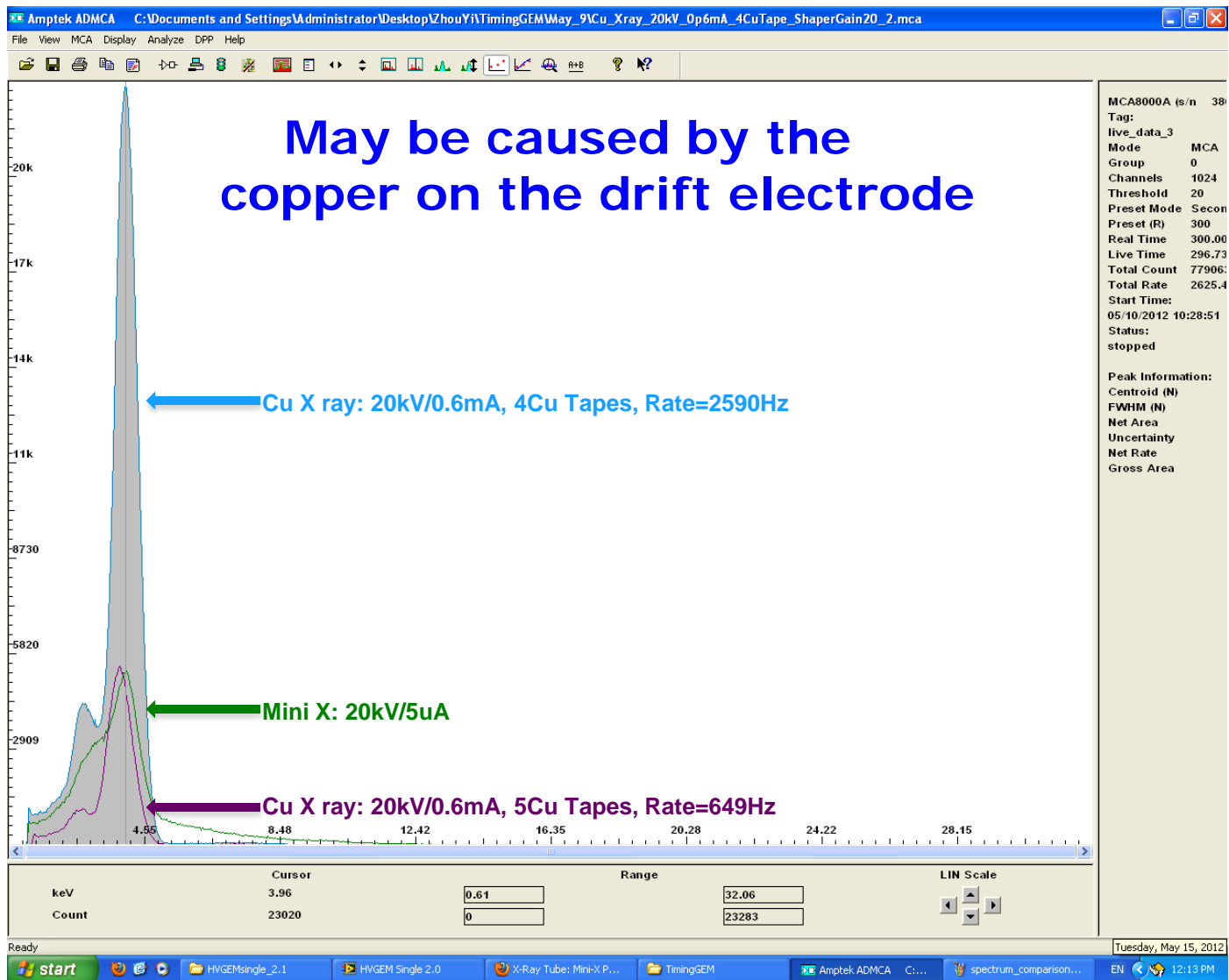
# Energy transfer caused by the drift electrode

## The effect of the cover & drift electrode



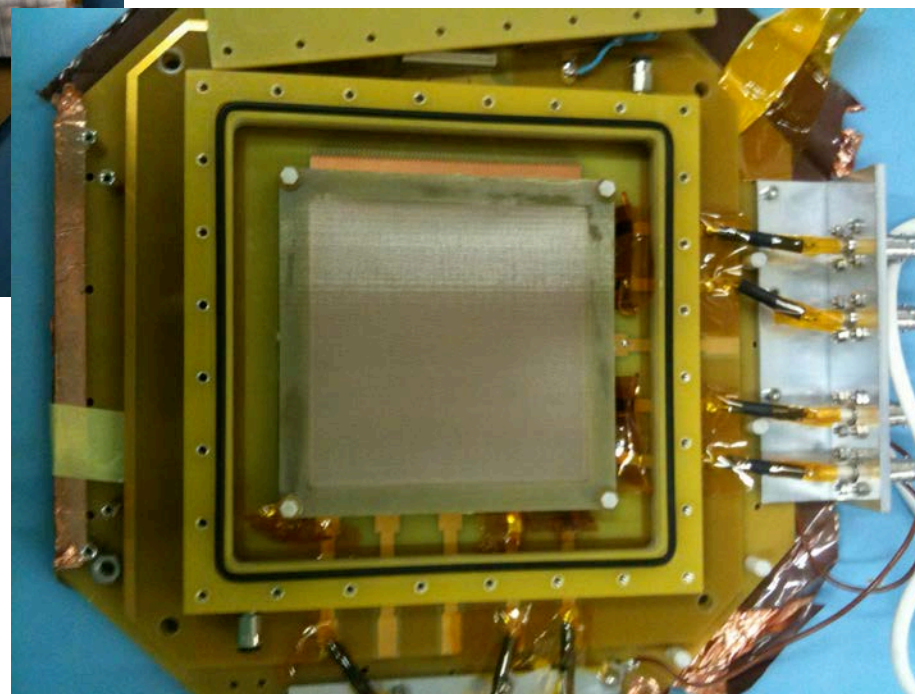
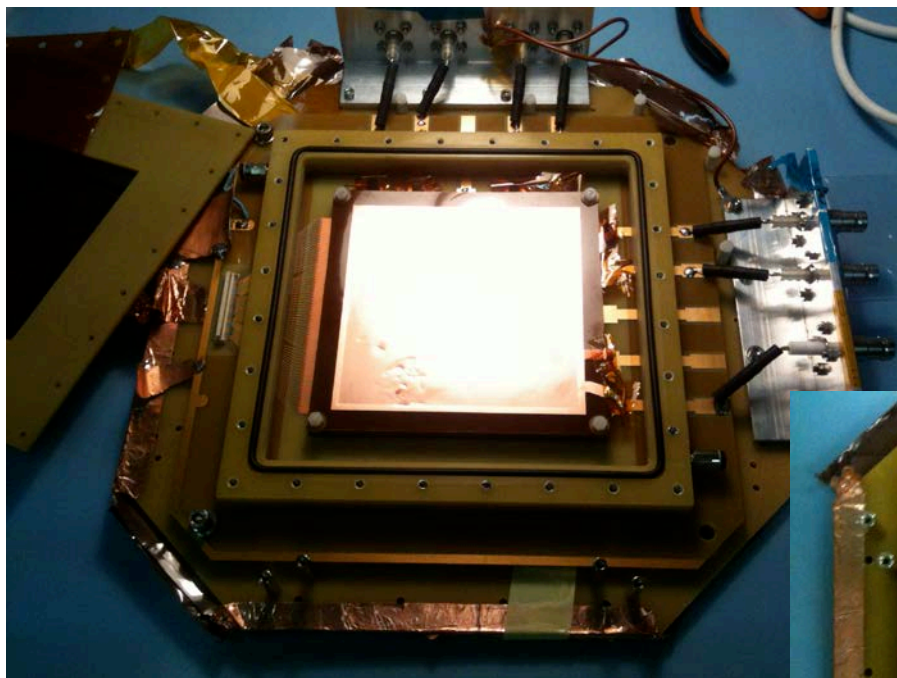
# Energy transfer caused by the drift electrode

## The effect of the cover & drift electrode



# Energy transfer caused by the drift electrode

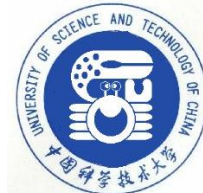
## The effect of the cover & drift electrode



**The peak position  
and shape changed!!!**

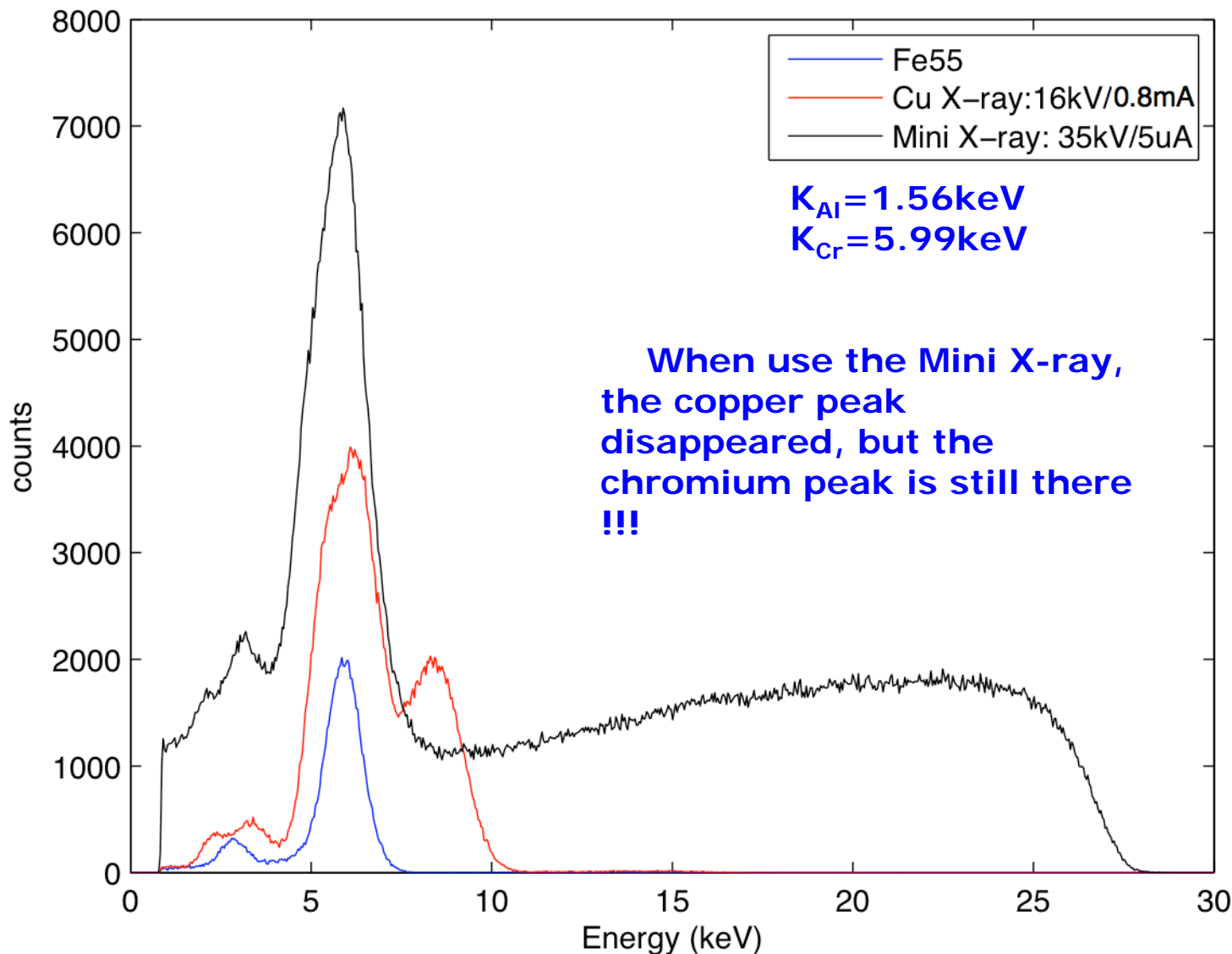
**The picture lost !!!**

# Spectrums(<sup>55</sup>Fe, Cu Xray, Mini Xray)



Measured by the single-wire detector

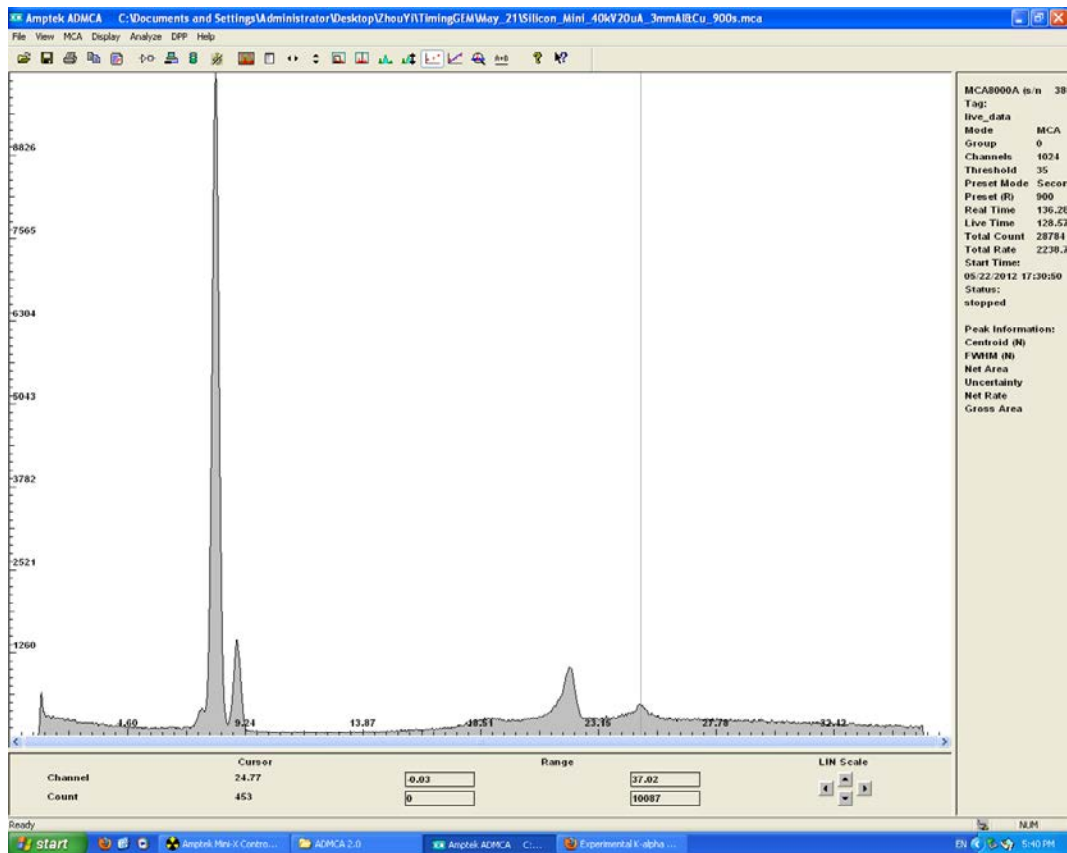
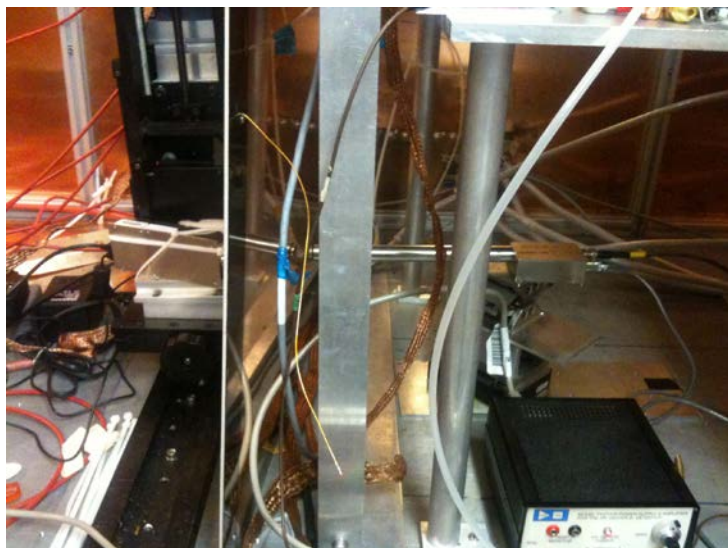
The effect of the cover & drift electrode



# Energy transfer caused by the drift electrode

Measured by the silicon detector

The effect of the cover & drift electrode



The copper line is dominating when close to the Cu-plate.



# Conclusions for the window & drift electrode effect

## The effect of the cover & drift electrode

### Conclusion (For large area chamber):

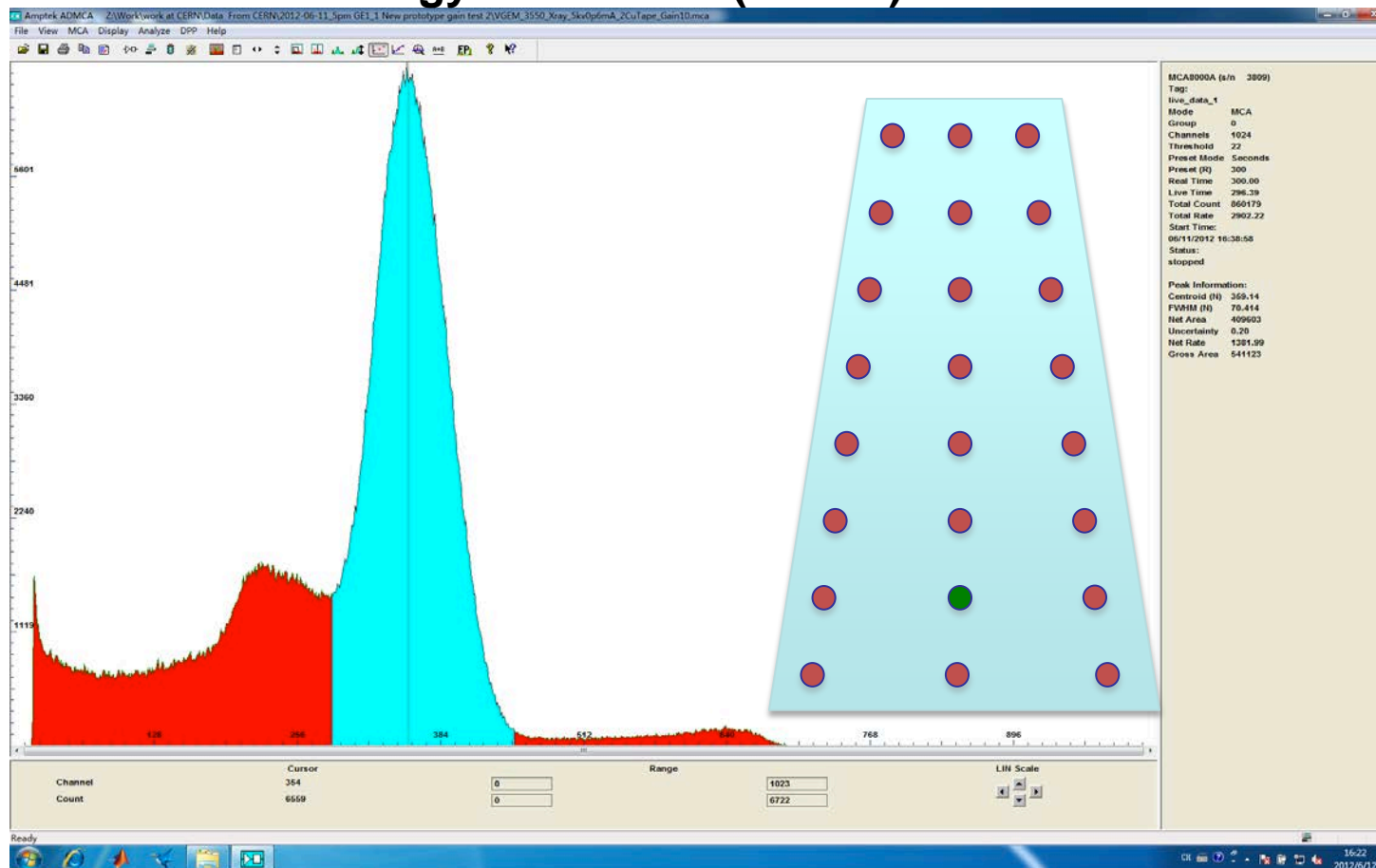
- *The structure of the detector should be as simple as possible;*
- *The X-ray energy should be close to or less than the  $K\alpha$  Line of the metal on drift electrode and the cover of the detector.*

**Good Example:** Use copper X-ray as the source;  
Use the copper plated PCB as the drift electrode;  
Use blind Vias on PCB as the windows;

# Energy transfer caused by the drift electrode

The effect of the cover & drift electrode

Energy Resolution (FWHM) : 19.61%



GEM based detector for upgrade of the CMS forward muon system  
 Stefano Colafranceschi  
 RD51 mini week 14 June 2012



# Where this problem come from?*(For me!!)*

## The Charging up effect

— Fe55 Rate:456Hz  
— Cu X-ray:662Hz

**K $\alpha$  of Ar : 3keV**

**<sup>55</sup>Fe Line: 5.9keV**

**Cu Line: ~ 8keV**

**Peak position of Cu X-ray:  
8keV-3keV=5keV < 5.9keV  
???**





# *The Charging up effect*

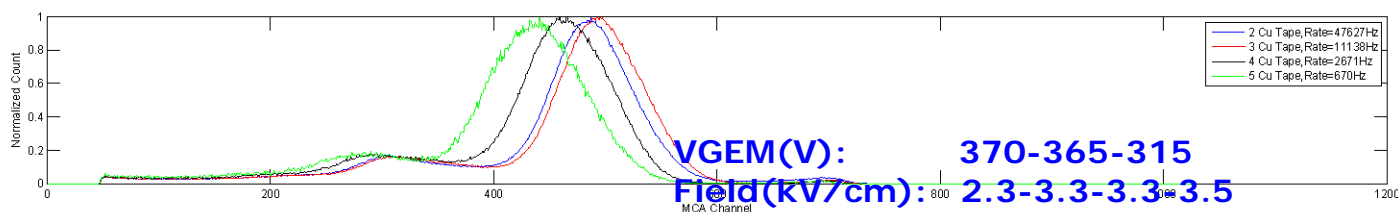
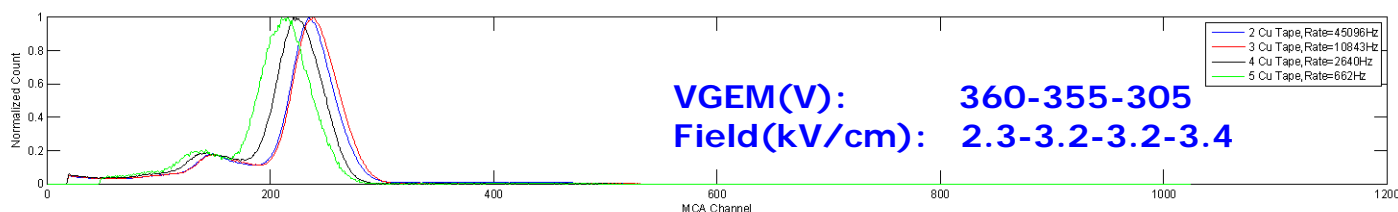
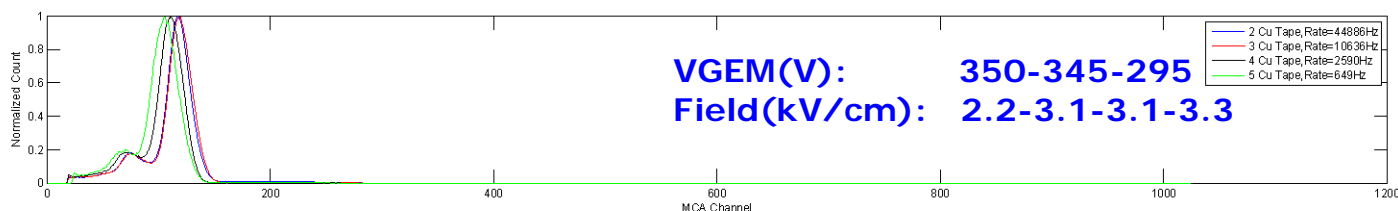
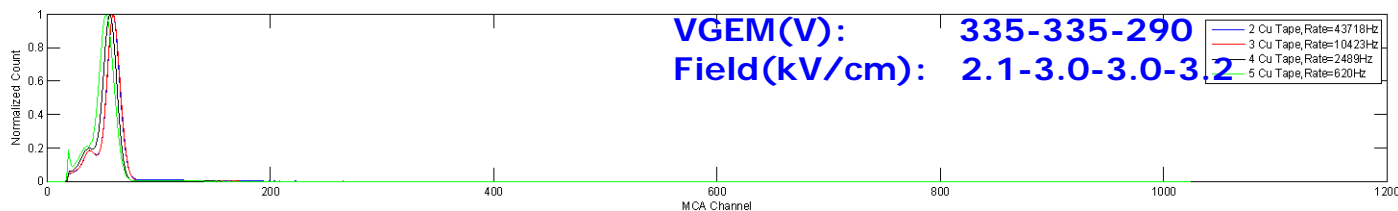
*The Charging up effect*

**In GEM detectors, charges can be captured by the Kapton that separates top and bottom electrodes. The collection of a substantial number of charges on the dielectric surfaces induces a modification of the field inside the GEM holes and a consequent variation of the GEM gain.**

# Spectrums of different rates

Rate changed by adding Cu tapes

The Charging up effect

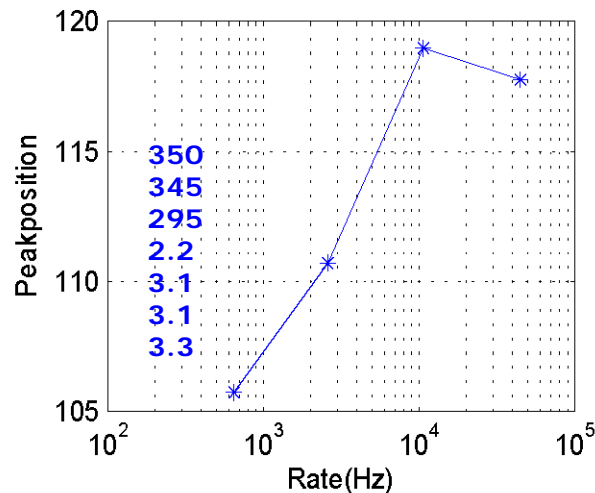
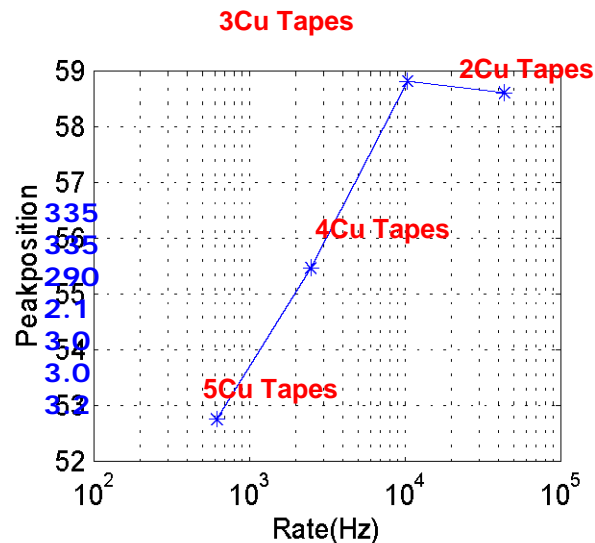


# Peak Position .VS. Rate

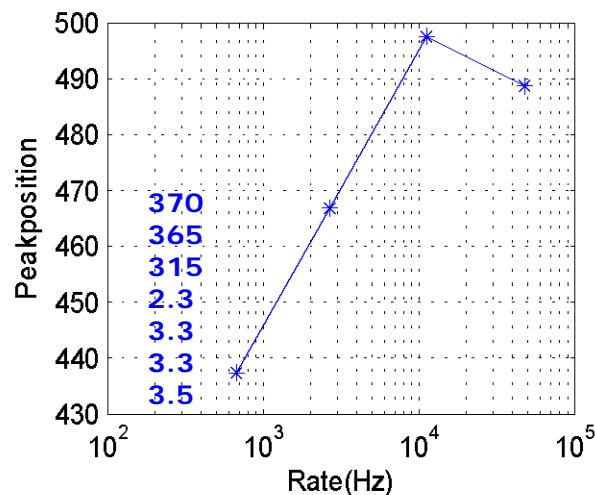
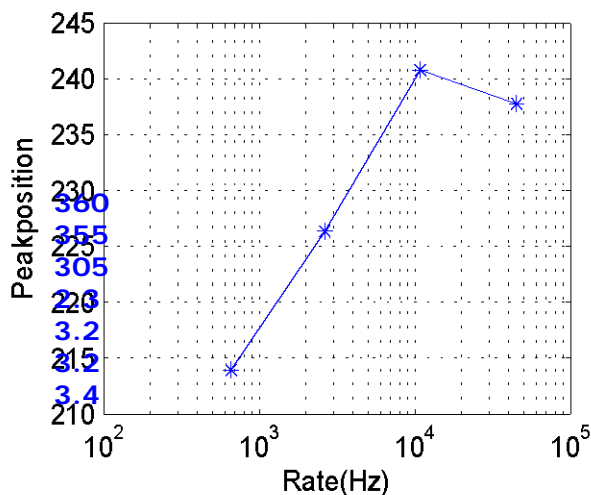
Rate changed by adding Cu tapes

The Charging up effect

VGEM1(V):  
VGEM2(V):  
VGEM3(V):  
E1(kV/cm):  
E2(kV/cm):  
E3(kV/cm):  
E4(kV/cm):

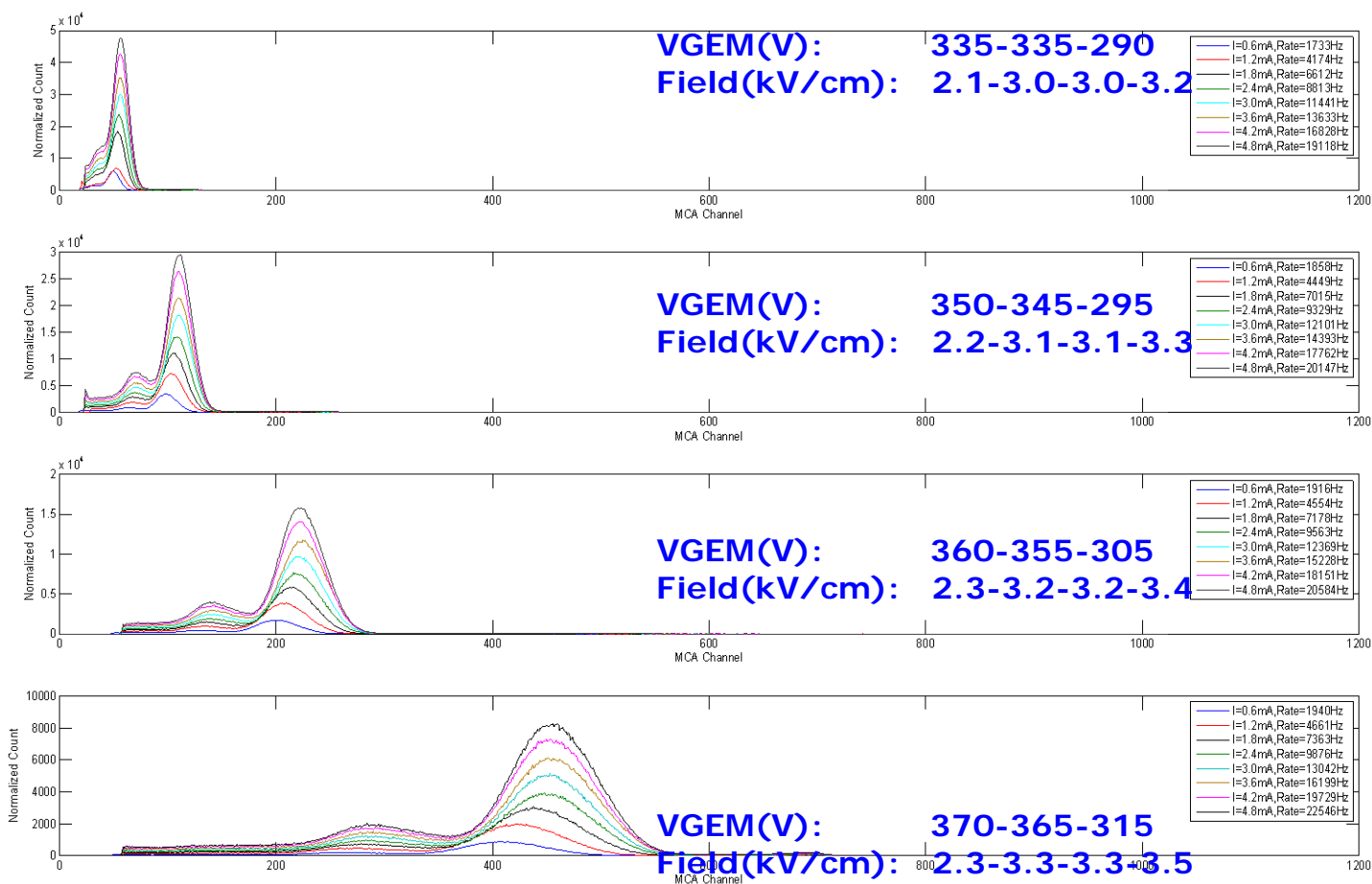


VGEM1(V):  
VGEM2(V):  
VGEM3(V):  
E1(kV/cm):  
E2(kV/cm):  
E3(kV/cm):  
E4(kV/cm):



# Spectrums of different rates

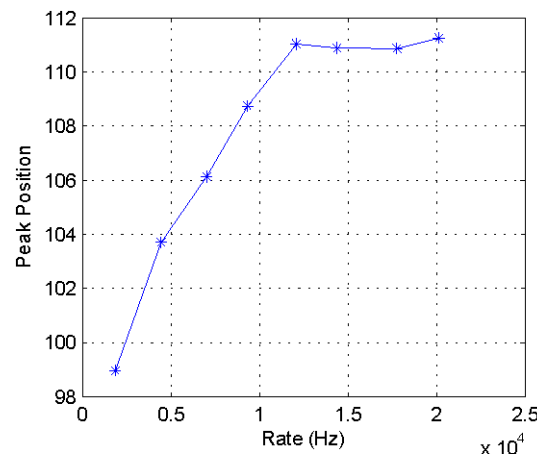
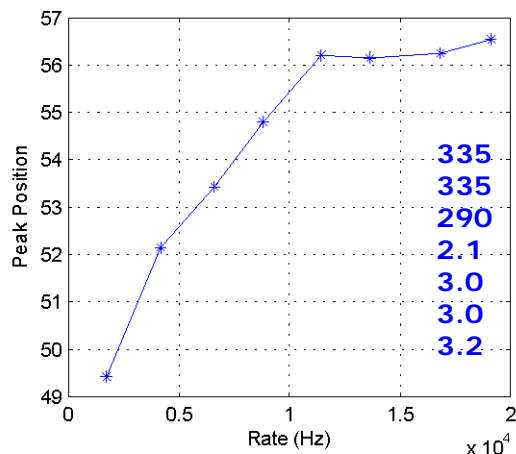
Rate changed by adjusting the current of the X-ray tube *The Charging up effect*



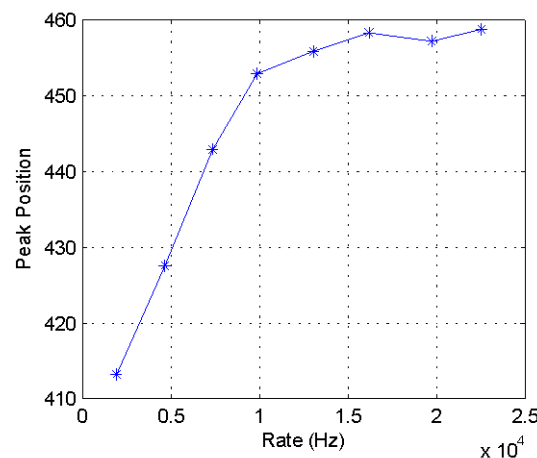
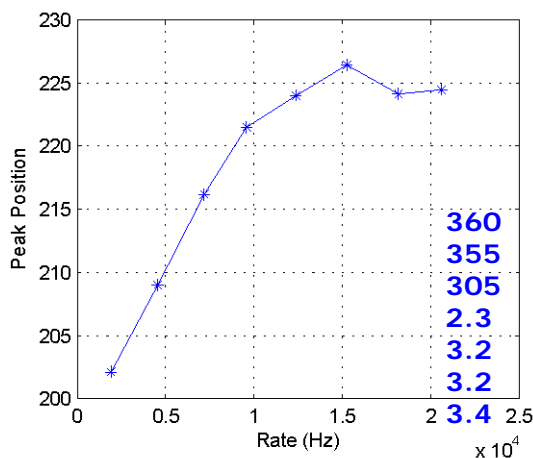
# Peak Position .VS. Rate

Rate changed by adjusting the current of the X-ray tube *The Charging up effect*

VGEM1 (V):  
 VGEM2 (V):  
 VGEM3 (V):  
 E1 (kV/cm):  
 E2 (kV/cm):  
 E3 (kV/cm):  
 E4 (kV/cm):



VGEM1 (V):  
 VGEM2 (V):  
 VGEM3 (V):  
 E1 (kV/cm):  
 E2 (kV/cm):  
 E3 (kV/cm):  
 E4 (kV/cm):





## **Conclusion of the charging up effect**

### **The Charging up effect**

#### **Conclusion (For large area chamber):**

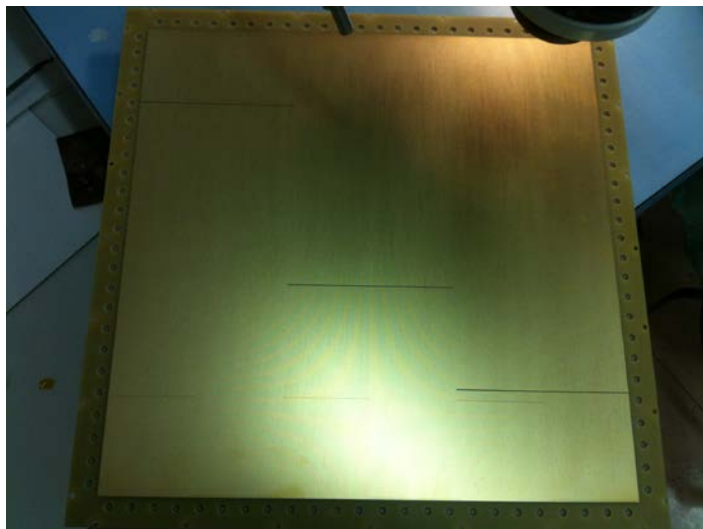
- ***This work is not finish yet, we want to test the gain .VS. density rate(Hz/mm<sup>2</sup>).***
- ***The gain calibration should use the X-ray source which can provide the same density rate as the JLab beam.***
- ***If it is possible, we should operate the GEM in the “density rate-gain” plateau, to avoid a large gain fluctuation caused by the rate variation.***

## ❖ *The 30cm × 30cm GEM of USTC*

- 1. The parts of the detector;*
- 2. First test of the detector;*

# Drift & Readout

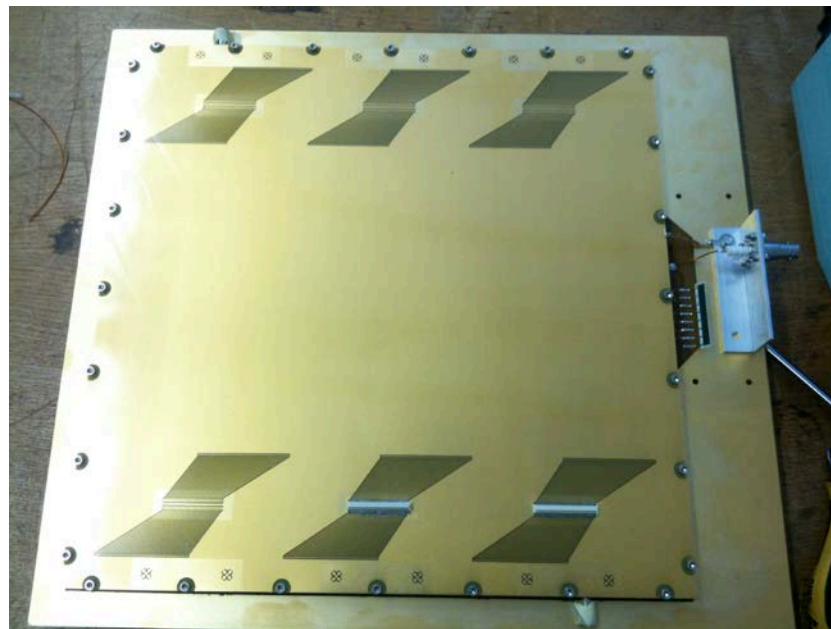
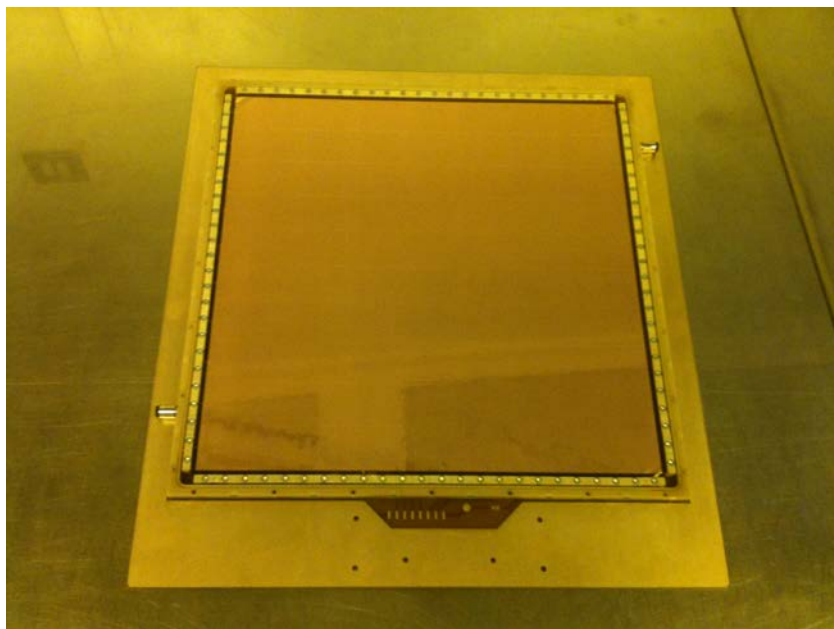
The parts of 30cm  $\times$  30cm GEM of USTC





# Detector & HV divider

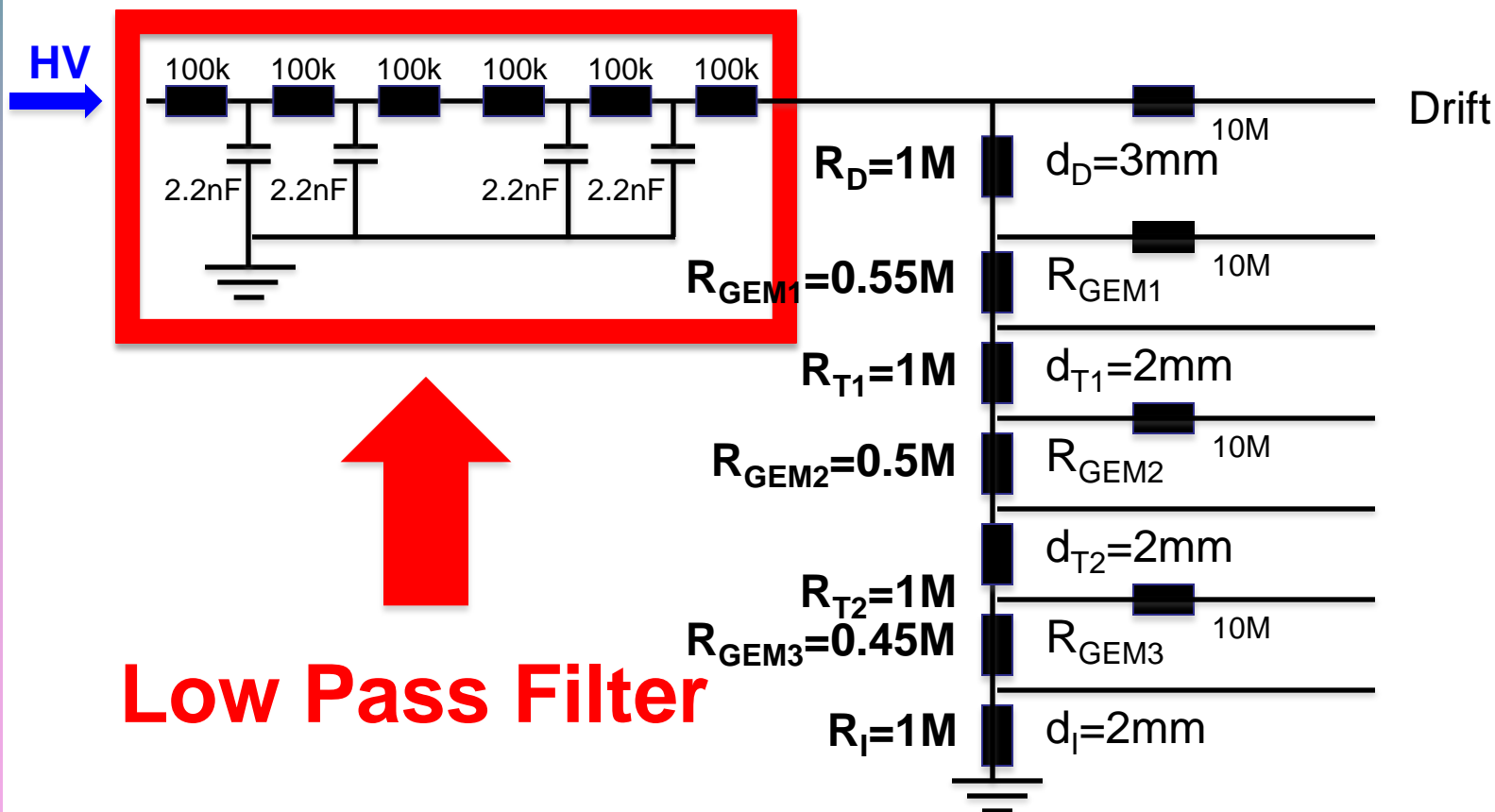
The parts of 30cm  $\times$  30cm GEM of USTC



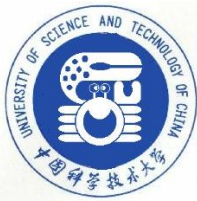
HV divider

# Connection of HV Divider & Filter

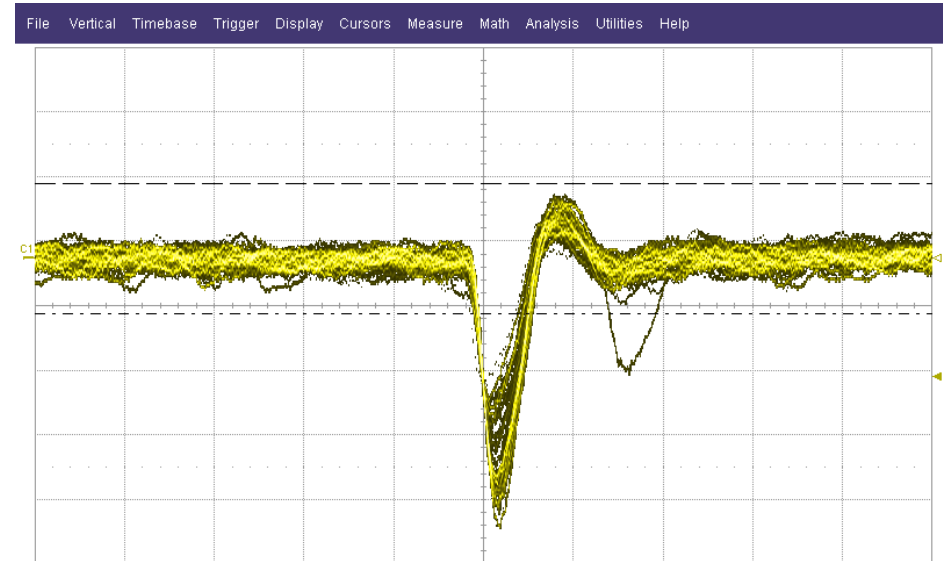
The parts of 30cm × 30cm GEM of USTC



# First test of the 30cm × 30cm GEM



*The first test of 30cm × 30cm GEM of USTC*



C1 DC50  
50.0 mV/div  
36.5 mV ofst  
---- -43.0 mV  
..... 57.5 mV  
Δy 100.5 mV

LeCroy

Timebase 0.00 μs  
WStream 2.00 μs  
500 S 25 MS/s  
Trigger C1 D0  
Stop -92.5 mV  
Edge Negative

7/12/2012 3:10:02 PM



# *Near future work*

- *Finish the 30cm × 30cm GEM detector and build a test platform for this detector;*
- *Continue working on the charging up effect;*
- *Design and build a 30cm × 30cm GEM at USTC*

**Thank You**