



GEM R&D from the Chinese Groups

Yi Zhou

University of Science & Technology of China

Four Chinese Groups

China Institute of Atomic Energy (CIAE)



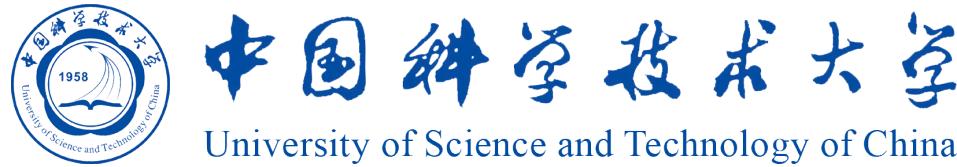
Lanzhou University



Tsinghua University

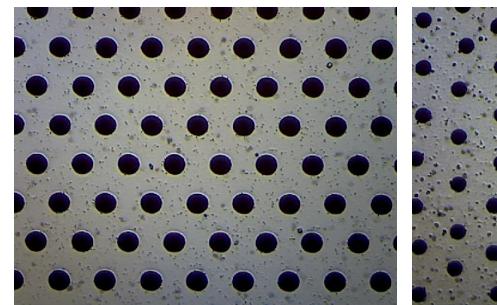


University of Science & Technology of China (USTC)

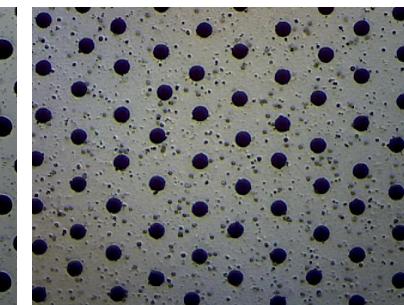


The Study of GEM Foils at CIAE

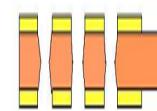
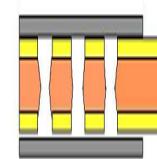
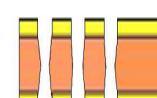
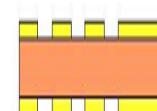
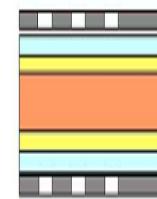
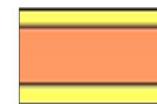
1. Kapton foil covered with copper has got from the manufacturer in China;
2. Photoresist coating and masking
Cooperated with the factory, can make **$50\mu\text{m}$ diameter and $5\text{cm}\times 5\text{cm}$ total area mask plate**;
3. Copper etching have some problems, they could be solved after getting the technology transfer from CERN;
4. Kapton etching: CIAE has over 20 years experience of nuclear pore foil production and kapton etching;
5. Clean room is ready for the study of GEM foils.



Mask plate of CERN
 $60\mu\text{m}$ diameter



Mask plate of CIAE
 $50\mu\text{m}$ diameter



PCB Factory, THGEM Foil Production and Test (Collaborated with IHEP)

Laminator



Photo etching machine



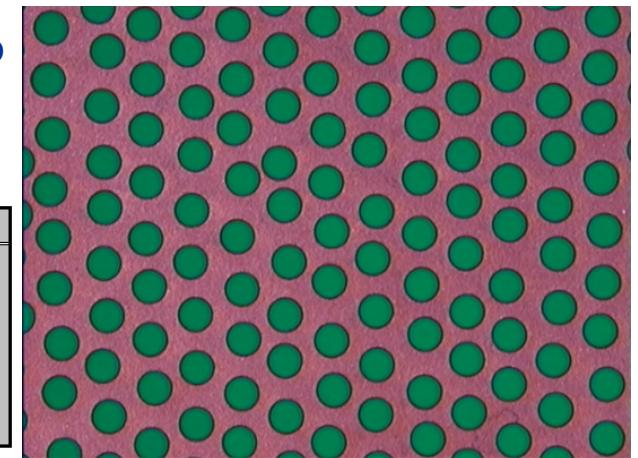
Etching Machine



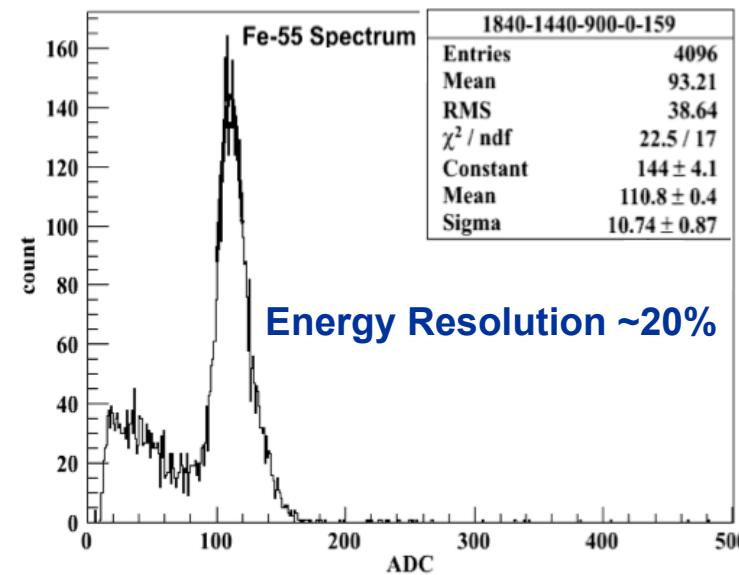
The PCB factory is located in the south of Beijing. They would like to make the GEM foils for us if we provide the technology support.

	GEM	THGEM
Manufacturer	CERN PCB Factory	Most PCB Factories
Cleanliness Level	Very High	Normal
Easy to Damage	Yes	No
Cost	High	Low
Detection Efficiency	High	Low
Spatial Resolution	~70μm	~300μm

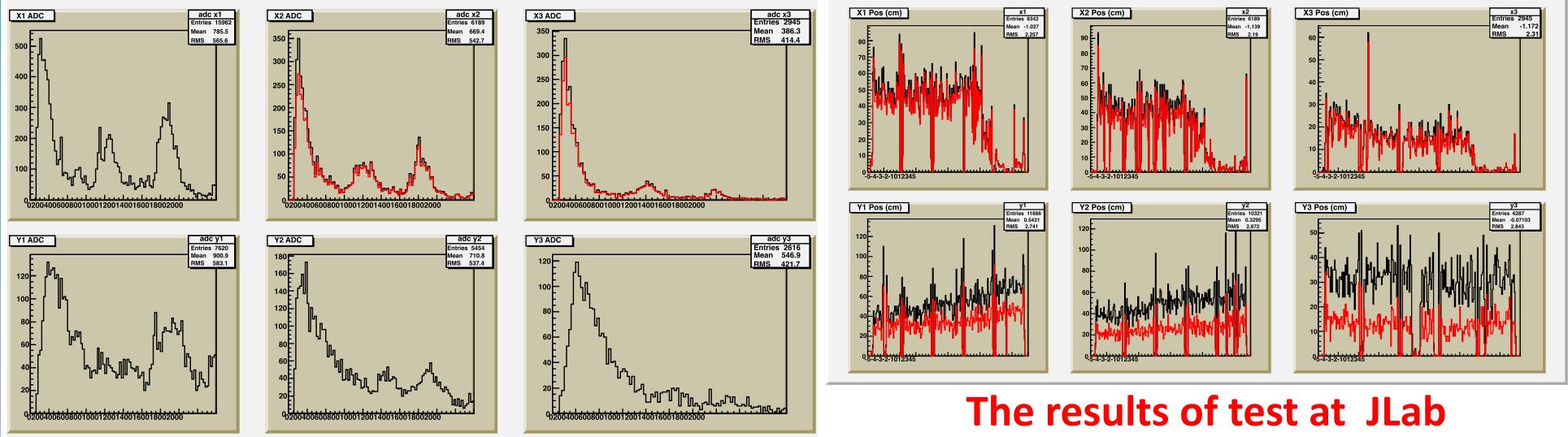
0.2mm Diameter THGEM Foil



THGEM Prototype

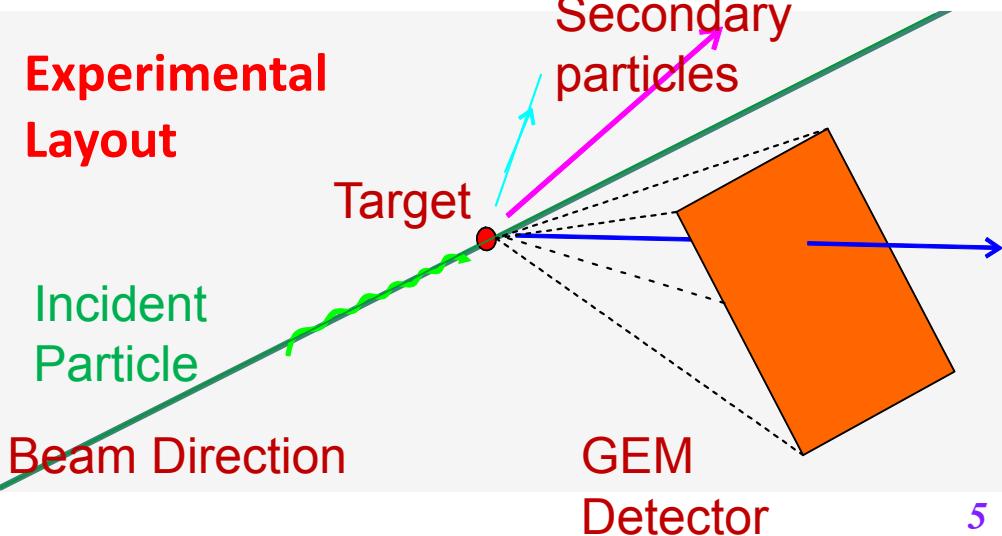


The Analysis of GEM Test at JLab 2011



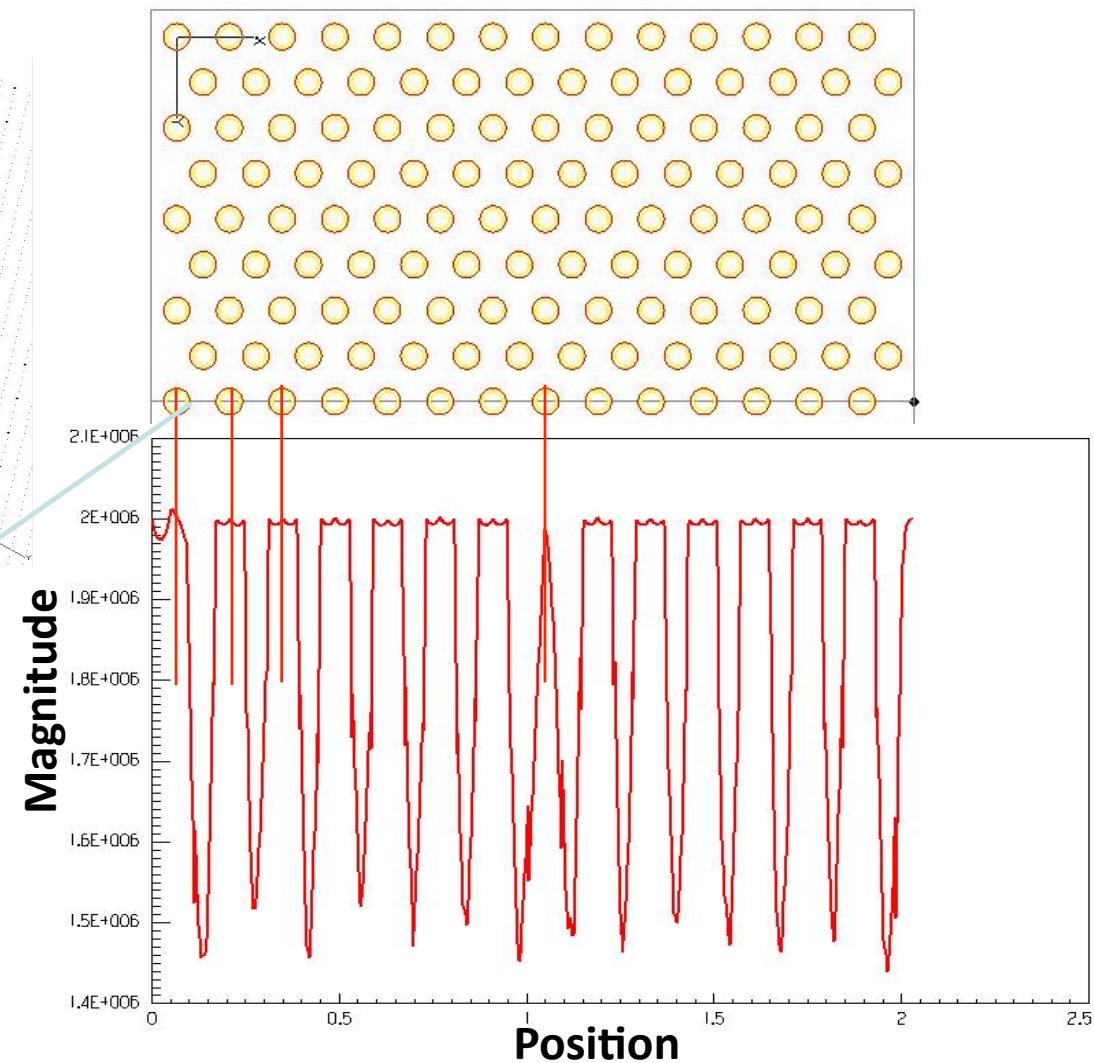
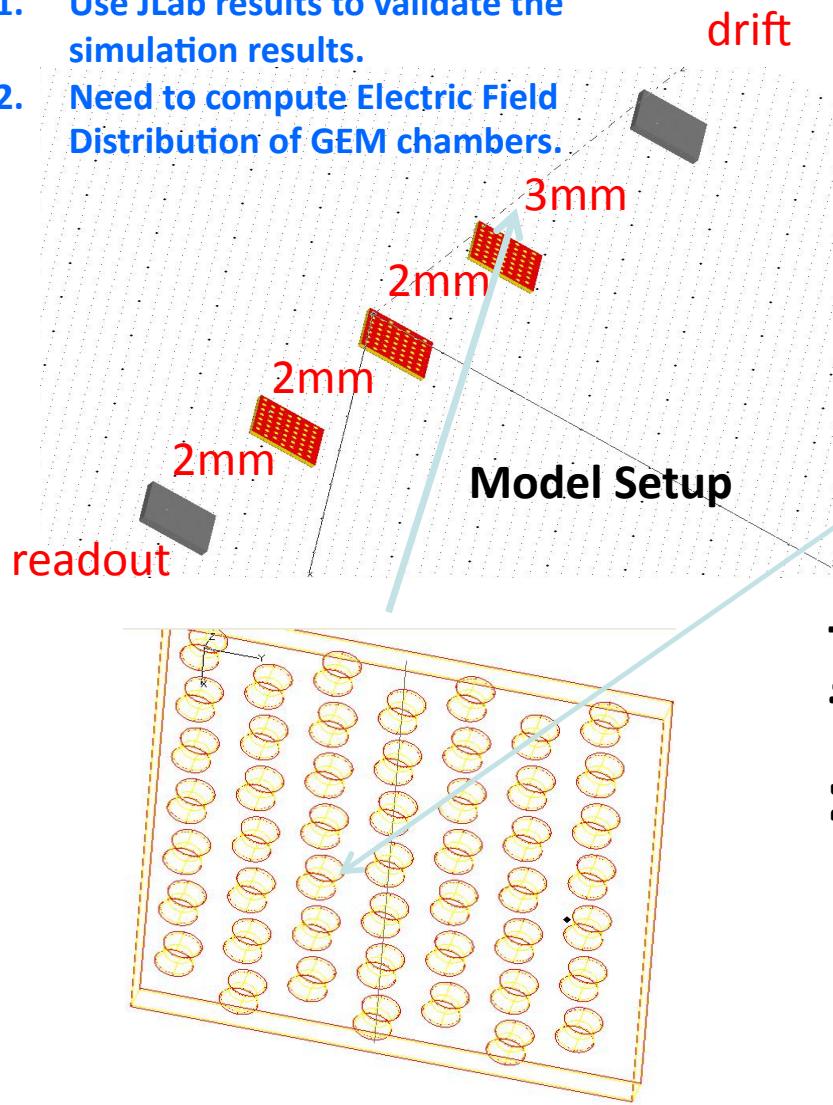
The results of test at JLab

1. No spatial resolution test.
2. Couldn't adjust operating parameters to explore better performance.
3. At present no available hardware, hoping to do some simulation work to seek optimum design parameters.



The Simulation of GEM Chamber Electric Field

1. Use JLab results to validate the simulation results.
2. Need to compute Electric Field Distribution of GEM chambers.





Near Future work Plan

1. A new way to make GEM foil has been discussed, and is going to be tried. If it works, then the procedure of GEM foil production will be simplified.
2. Test spatial resolutions for GEM and THGEM.
3. Design read-out electrode.
4. Input electric field data to Geant4 package, and compare Geant4 results to the data from the GEM test at JLab. Use simulation results to study spatial resolution, explore better operating parameters, and improve imminent experimental setup at CIAE.

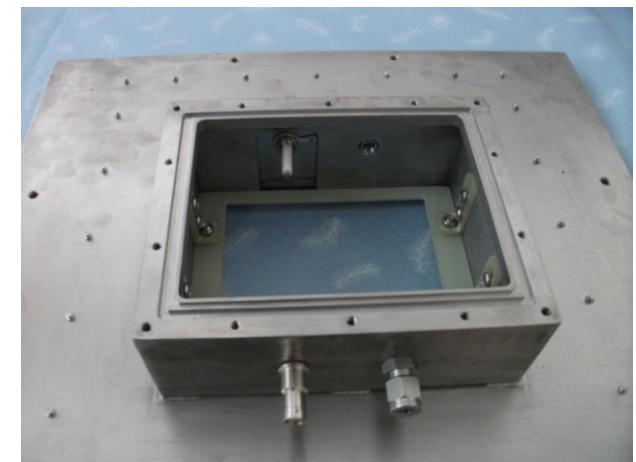
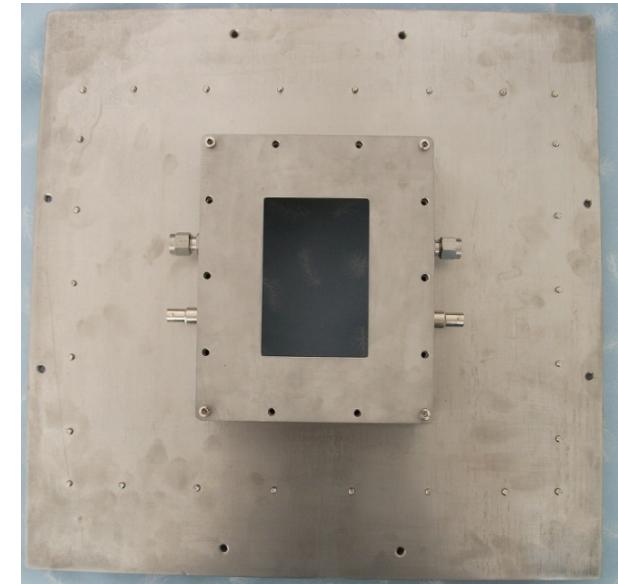
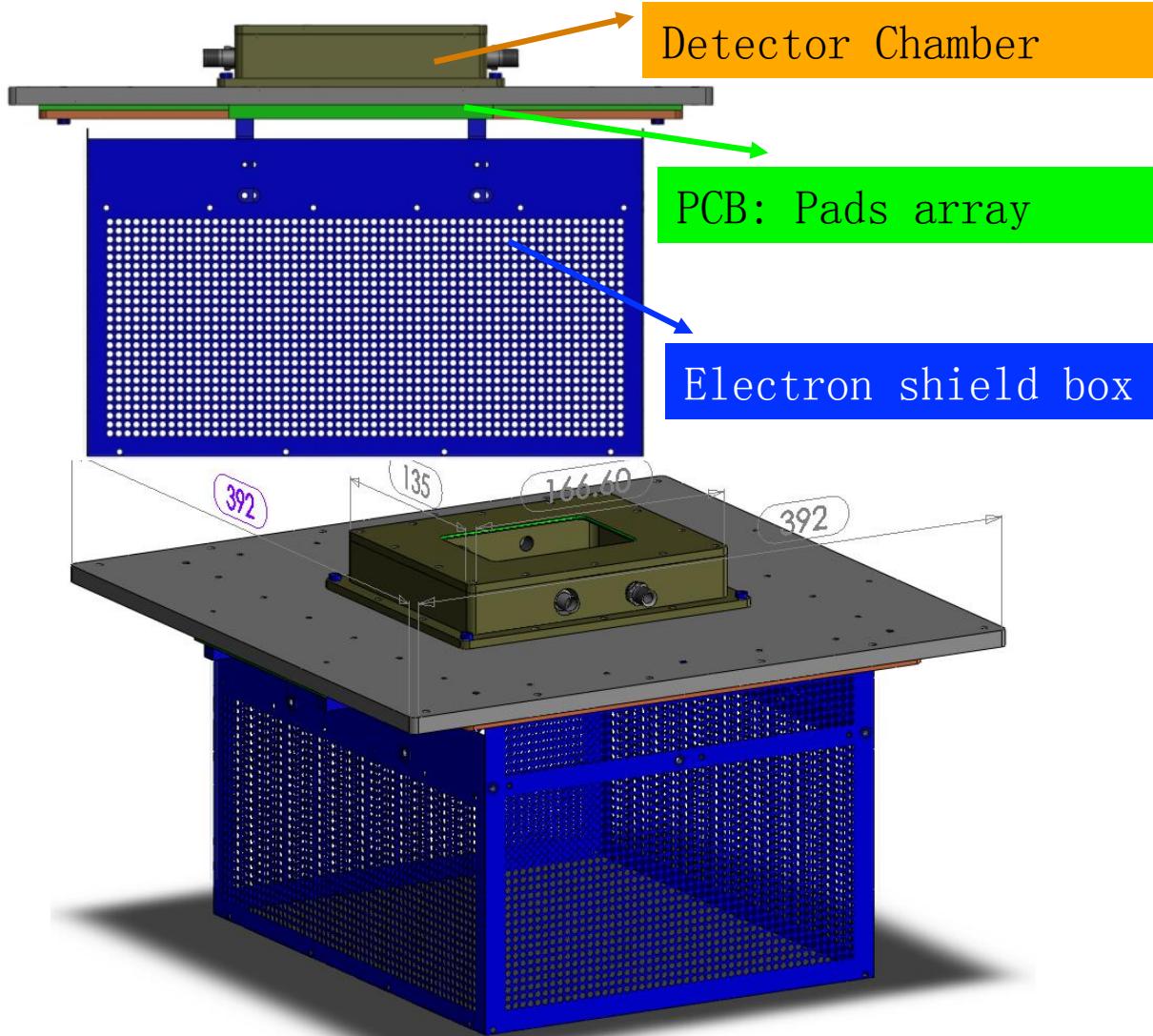


Micromegas R&D Activity in Lanzhou University

- Micromegas detector has been developed
- The imaging test has been done in the Am+Be neutron source

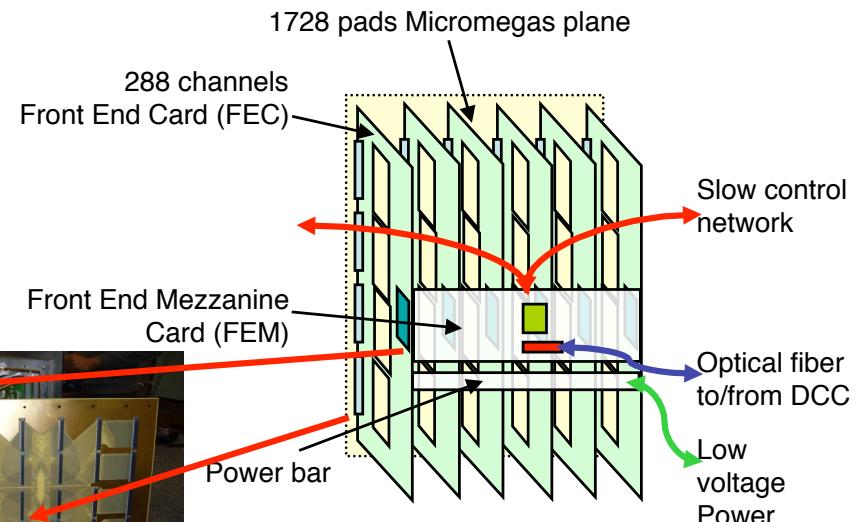
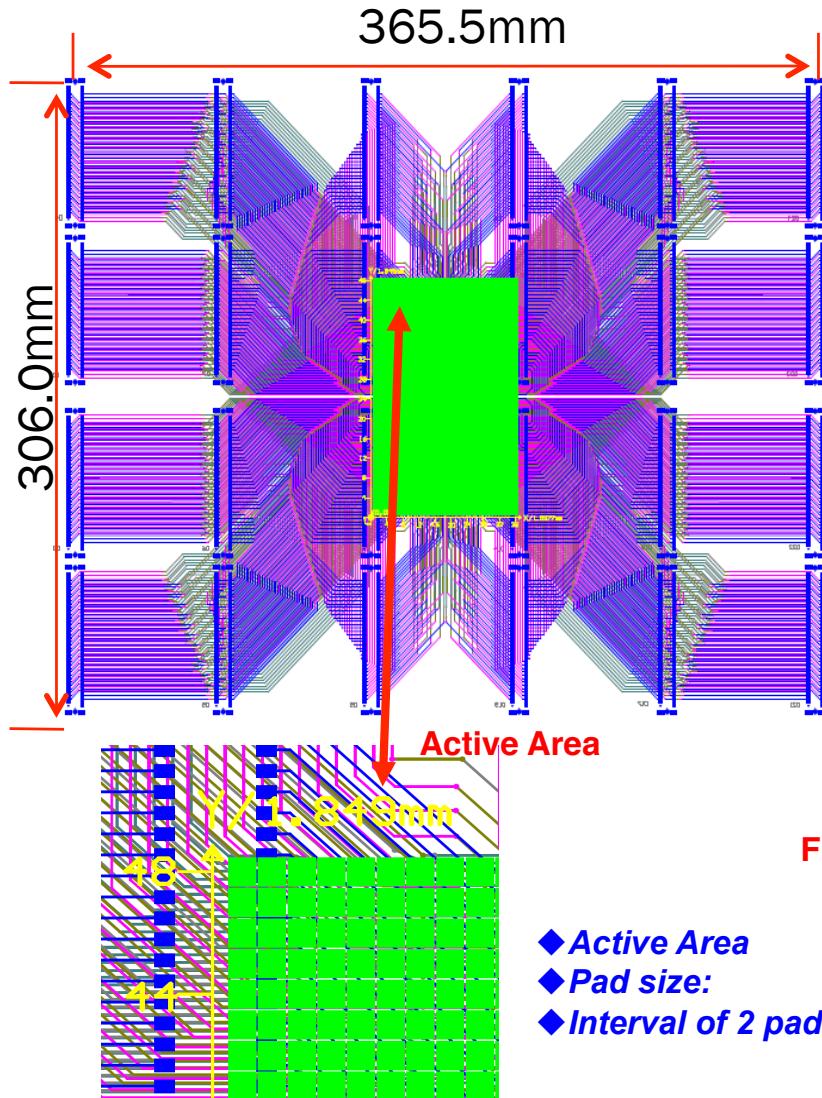


Micromegas Development in Lanzhou University





Readout Anode and FEE



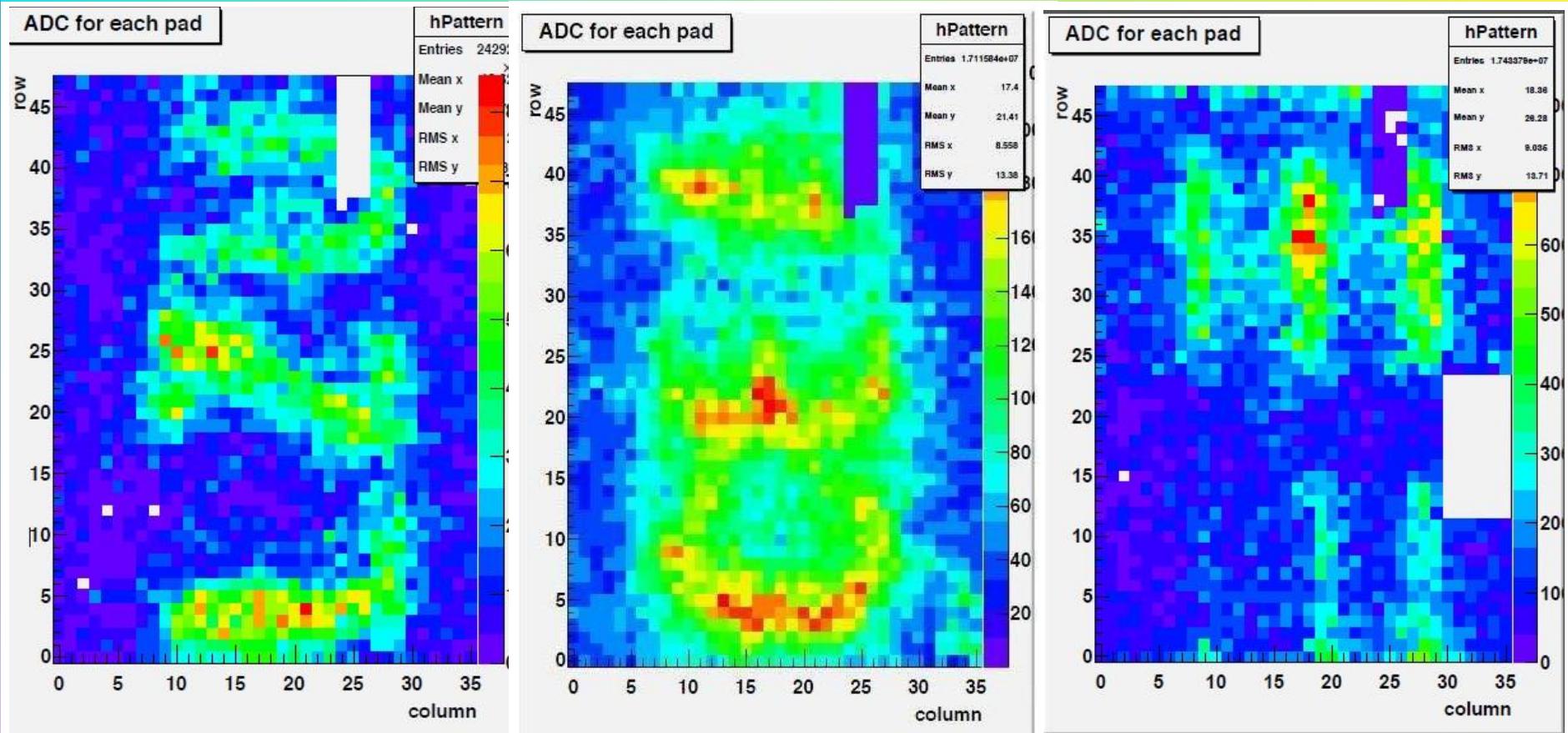
Front-End ASIC "AFTER"

- ◆ Active Area $88.6\text{mm} \times 57.4\text{mm}$
- ◆ Pad size: $1.75\text{mm} \times 1.50\text{mm}$
- ◆ Interval of 2 pads: 0.10mm





Micromegas Neutron (Am+Be source) Imaging Results



L Z U

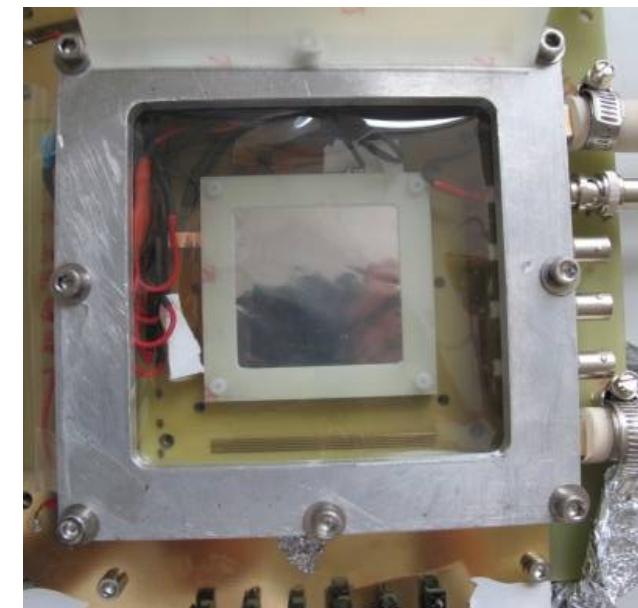
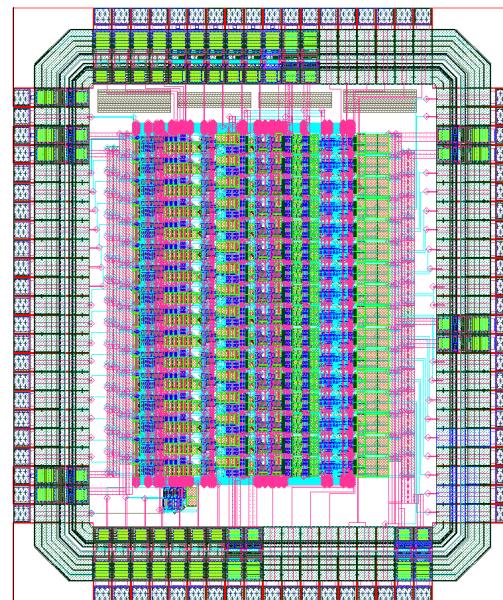
C E A

Slits

Near Future Work Plan

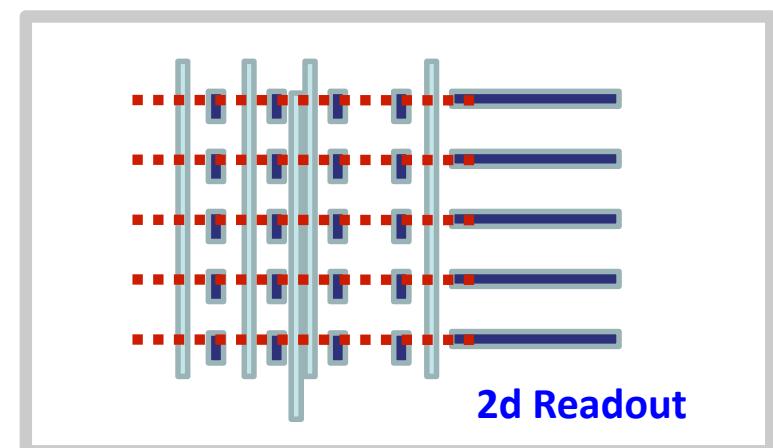
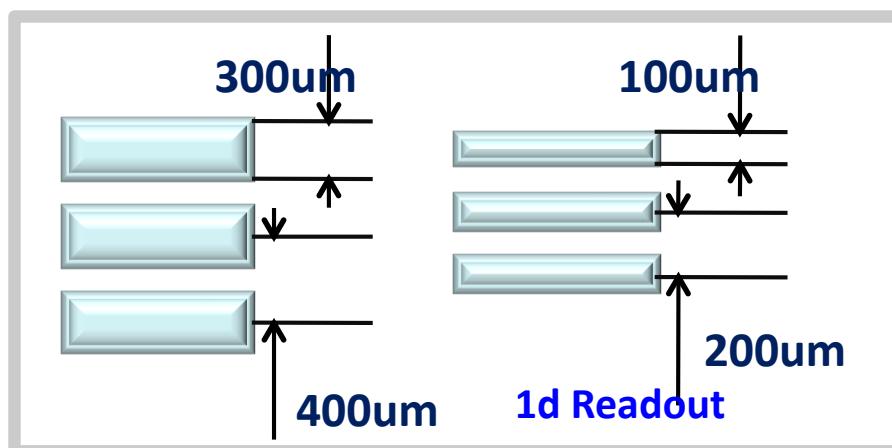
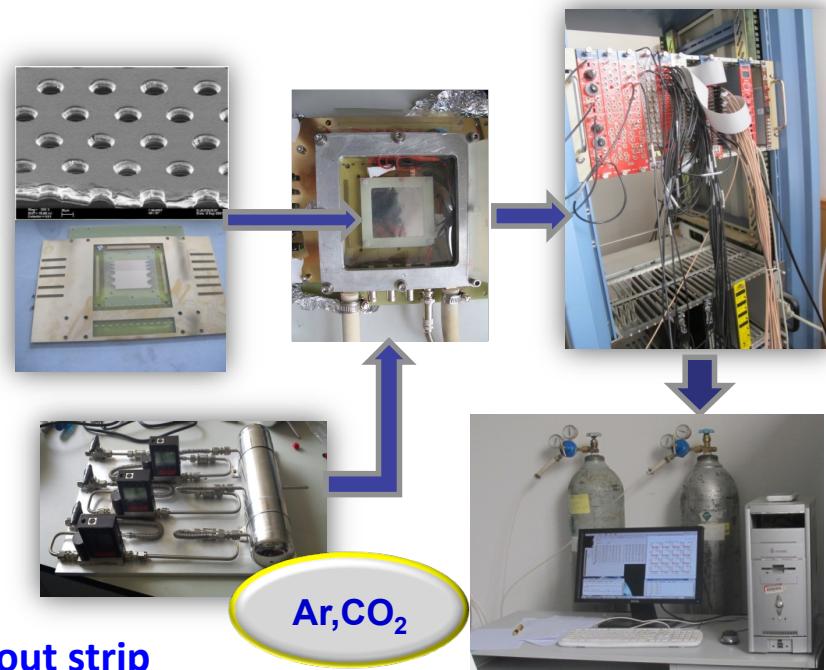
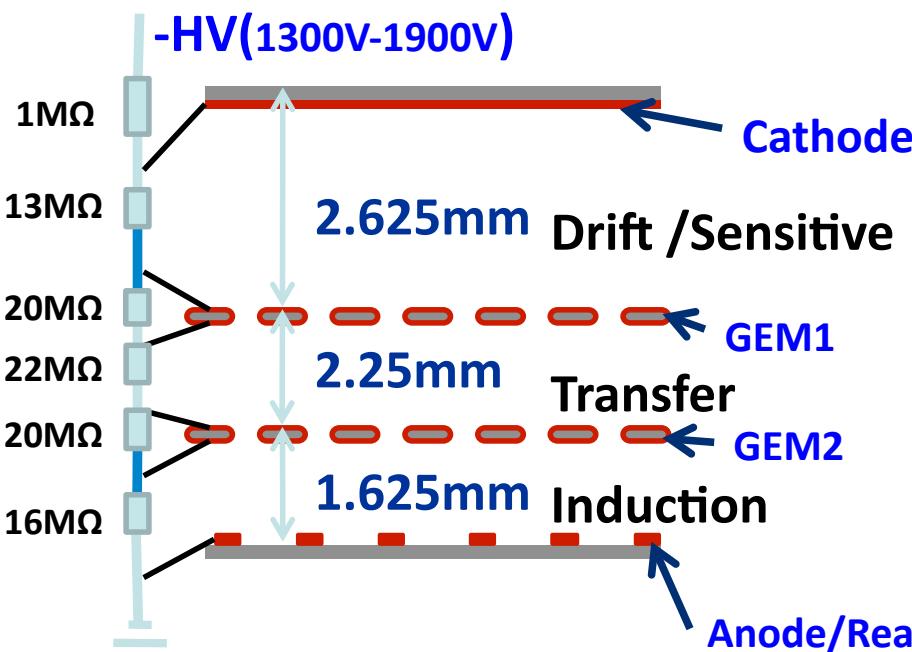
- DAQ system setup based on the Micromegas and “AFTER” chip (Up to 2000 Channels)
- Build the large area GEM detector and a test platform
- Update the FEE, replace the “AFTER” by APV25-S1

- GEM-based TPC readout (*by Yulan LI*)
- 16 channel CSA and shaping amplifier (*by Zhi Deng*)
- Planar GEM tracking detector prototype test (*by Zhigang Xiao*)
-

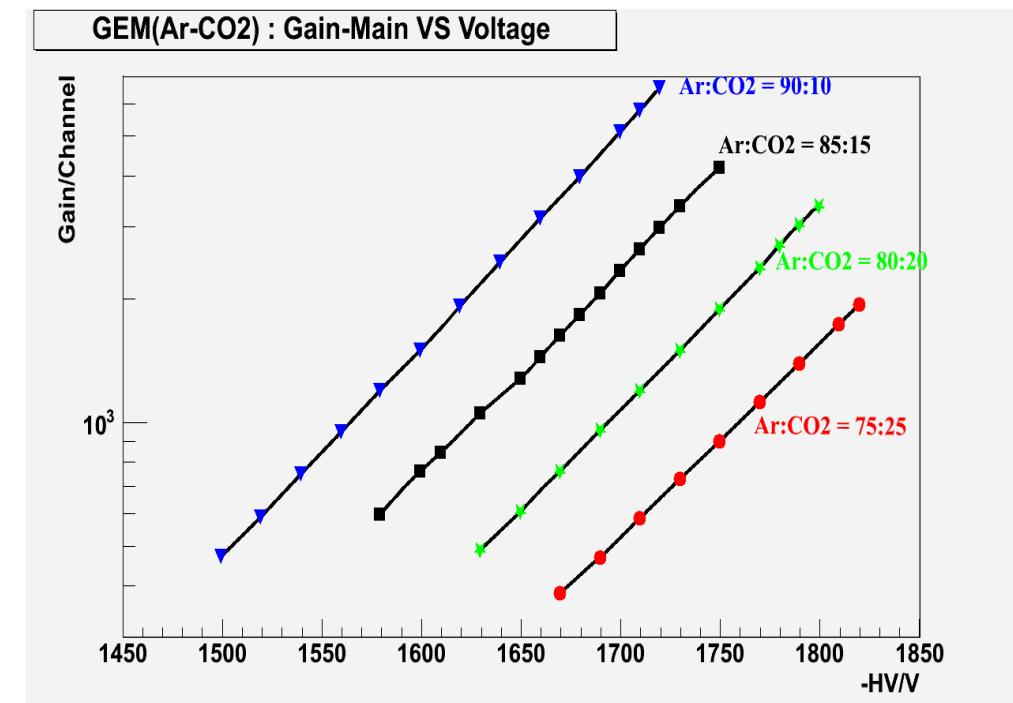
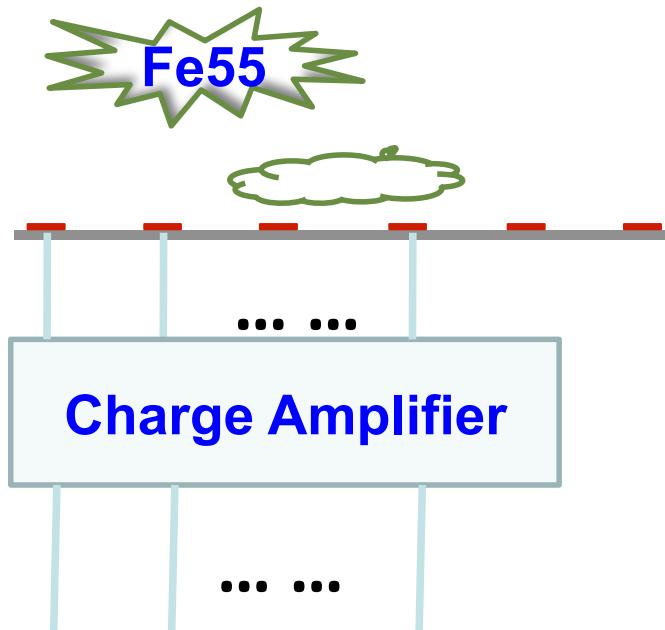




GEM Prototypes with two Readout Design



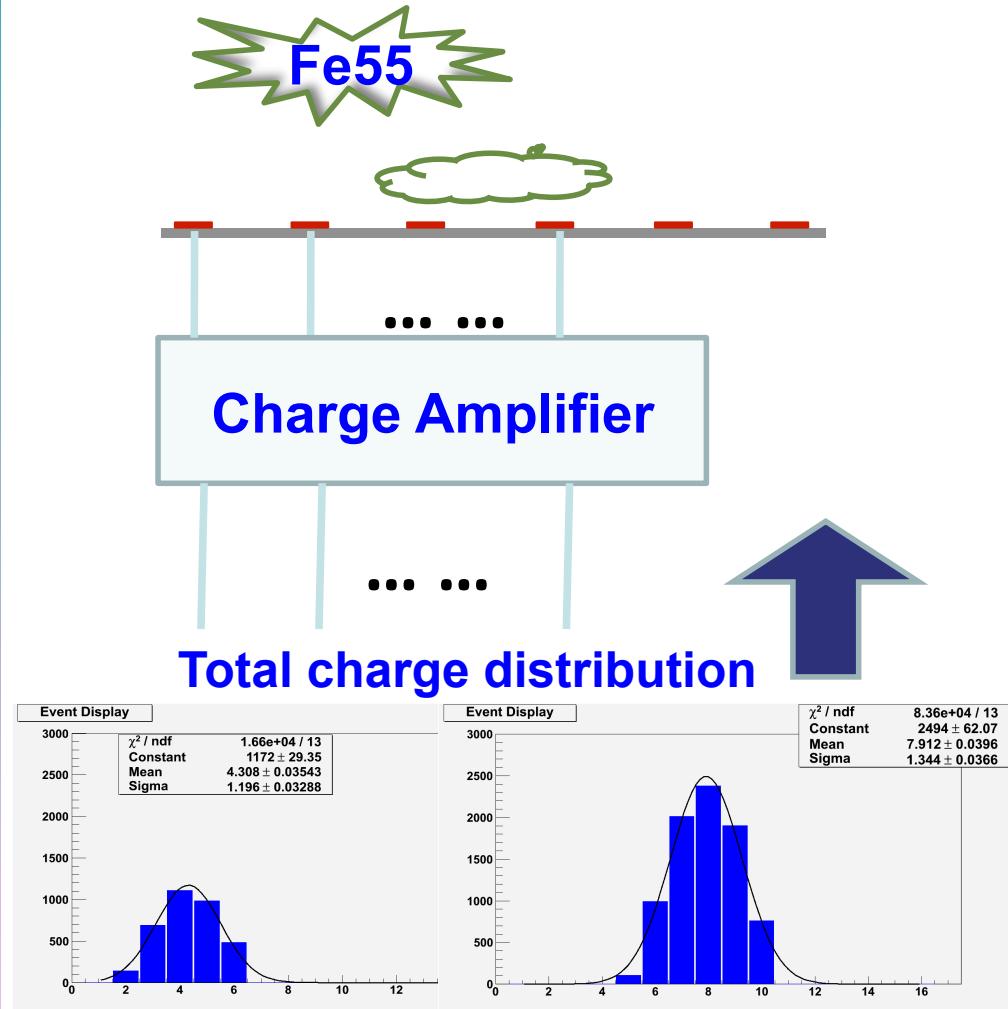
Test Results 1 : Effective Gas Gain



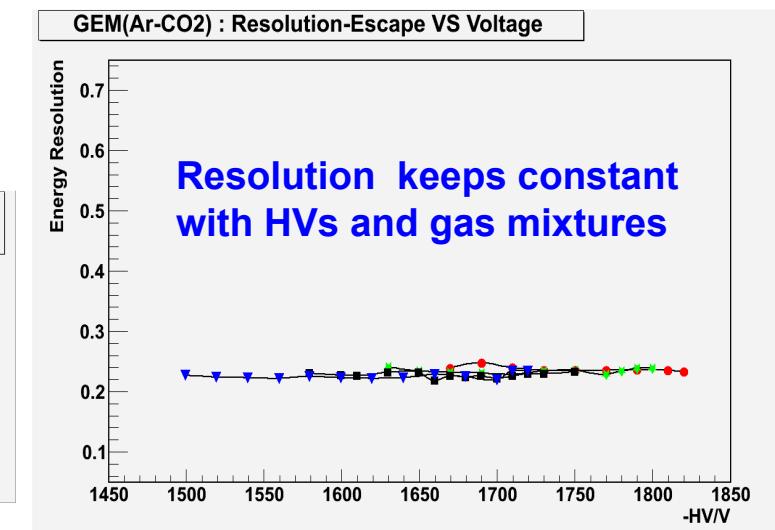
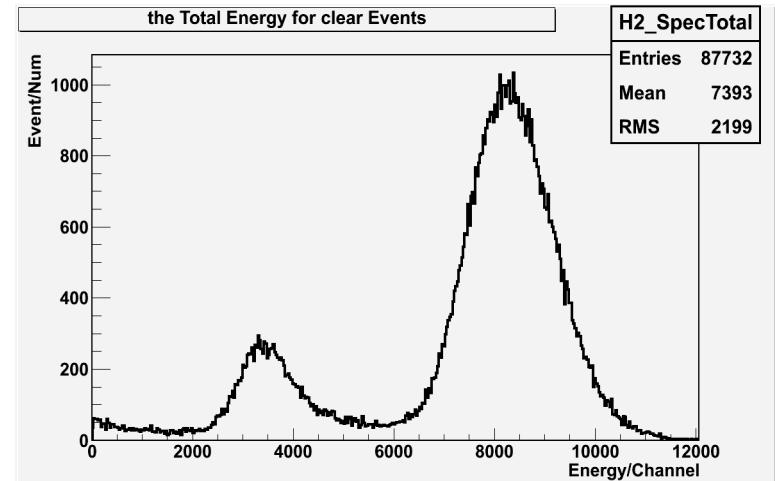
Working Gas: CO₂+Ar

- Gain factor stably increase with HV at all gas mixture

Test Results 2 : Energy Resolution



Wire fired in one hit



Near Future work Plan

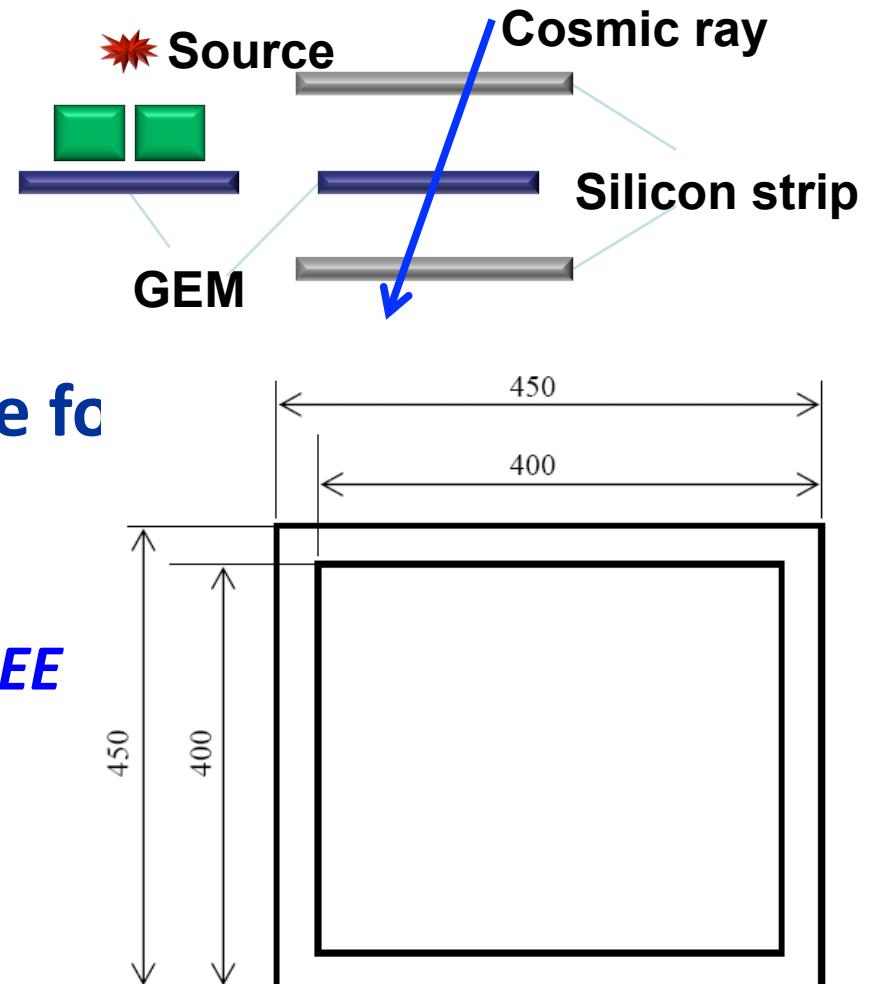
◆ Further detailed test, such as :

- ✓ Space resolution;
- ✓ Simulation;
- ✓ Timing performance;
- ✓ Proportionality of signal;

◆ To make a large area prototype for SoLID

- ✓ GEM foils ordered;
- ✓ FEE and VME DAQ (*ASIC-based FEE ordered for 150 channels*) ;

◆ Full simulation of SoLID-GEM

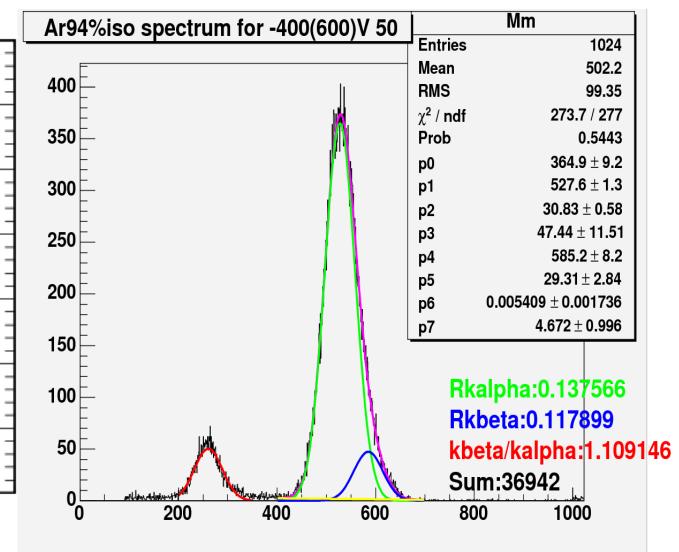
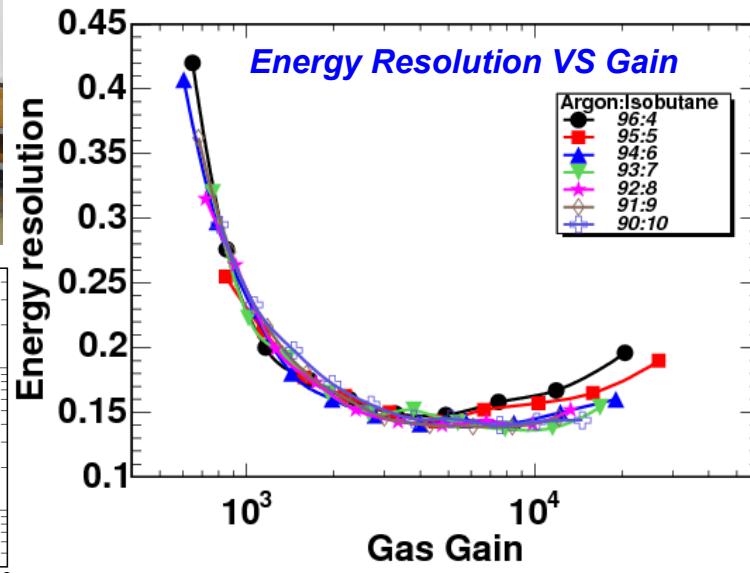
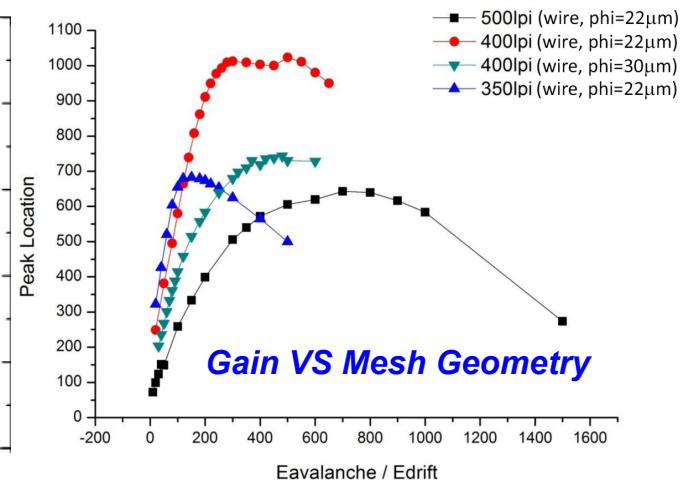
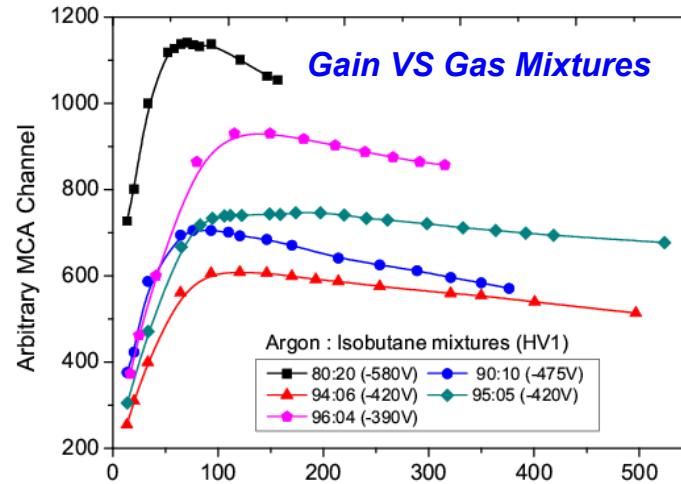
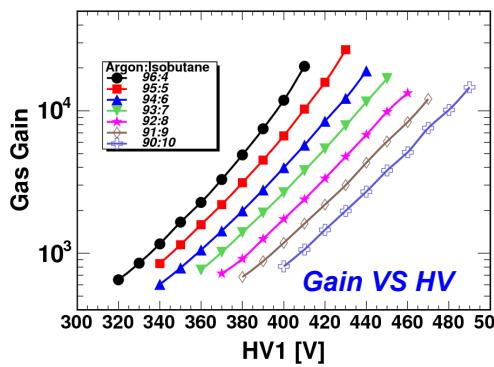
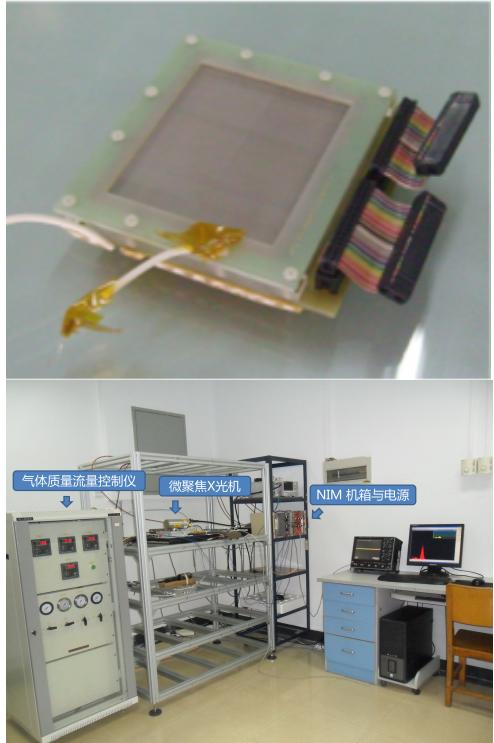




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Work on Micromegas R&D



Best Energy Resolution: ~13.7%

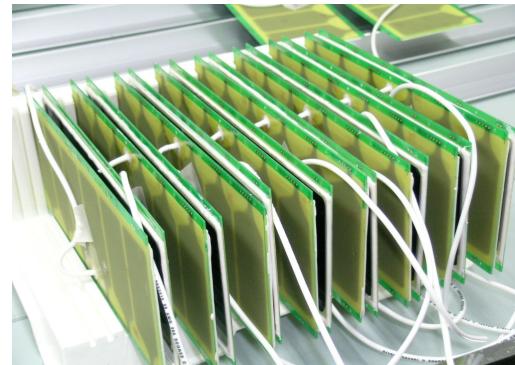
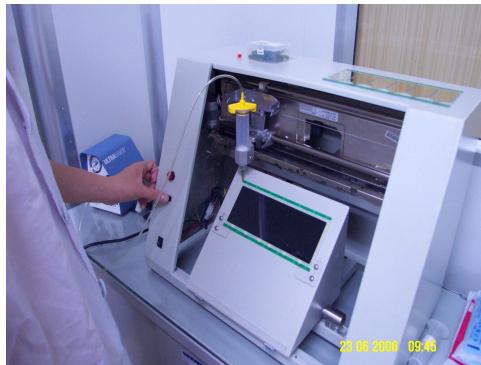


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Work on MRPC (STAR Collaboration)

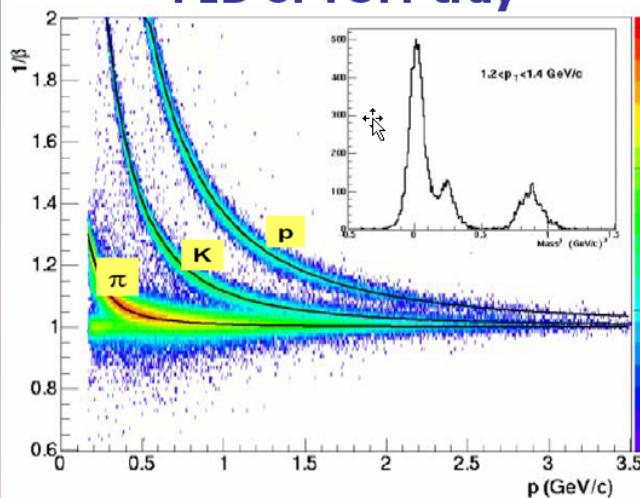
Mass Production in USTC



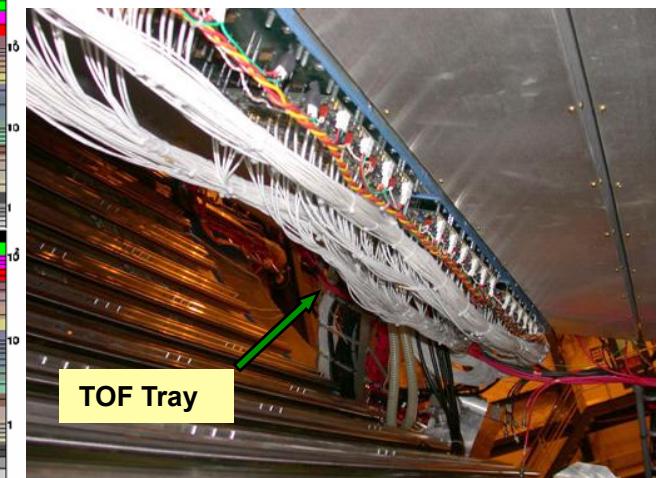
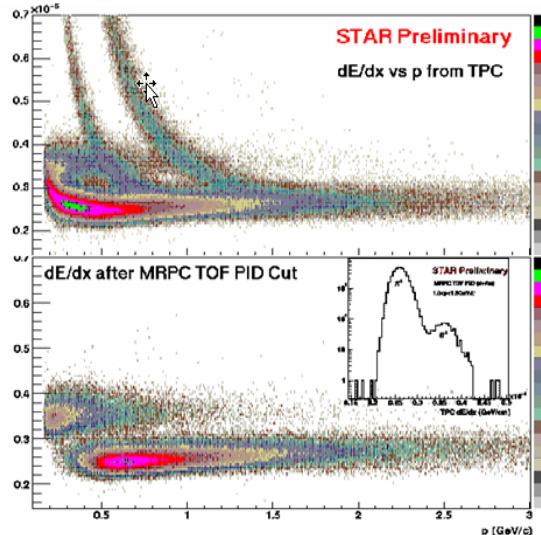
Beam Test Results

	Efficiency	Time Resolution
5-gap MRPC	>90%	70ps
6-gap MRPC	>97%	60ps
2 × 5-gap MRPC	>99%	50ps

PID of TOFr tray



dE/dx after TOFr PID cut

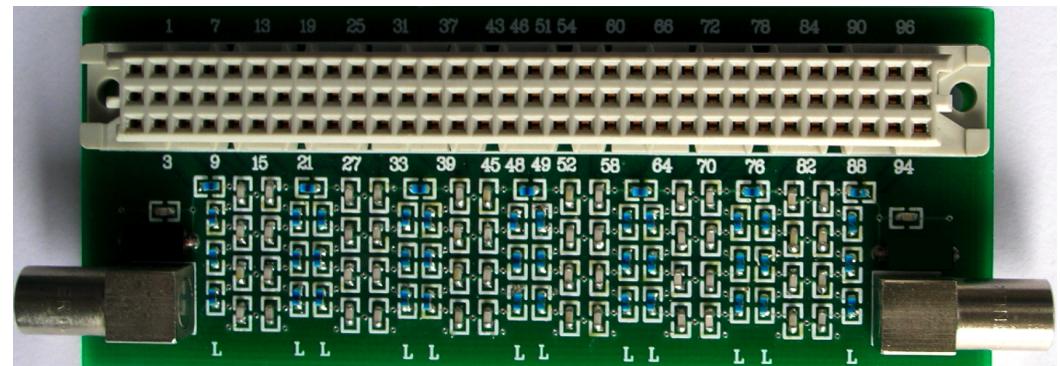
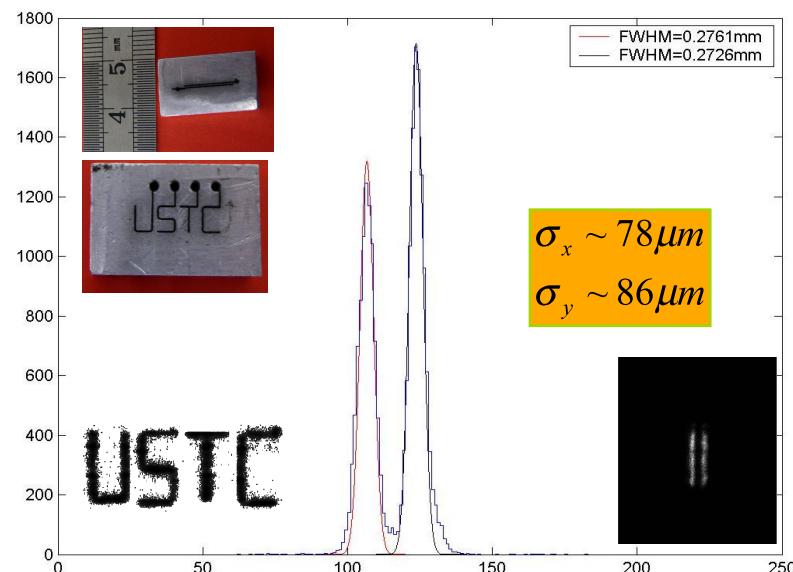
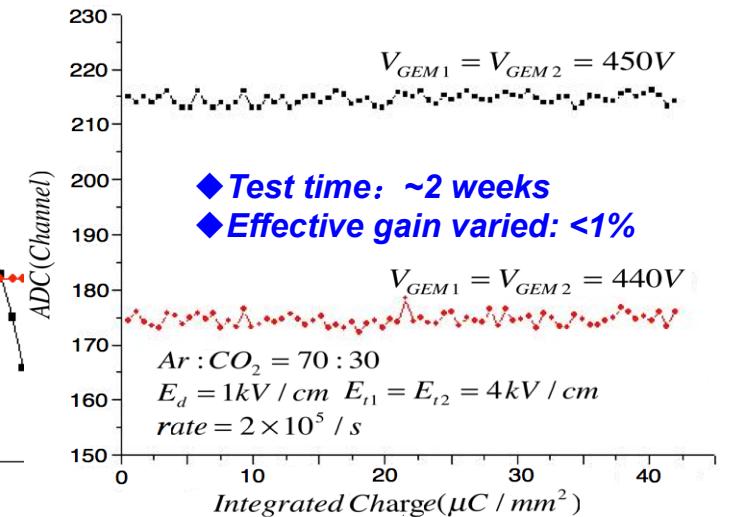
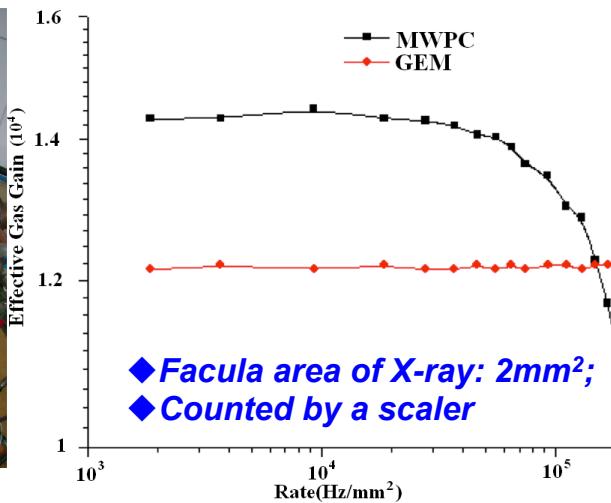
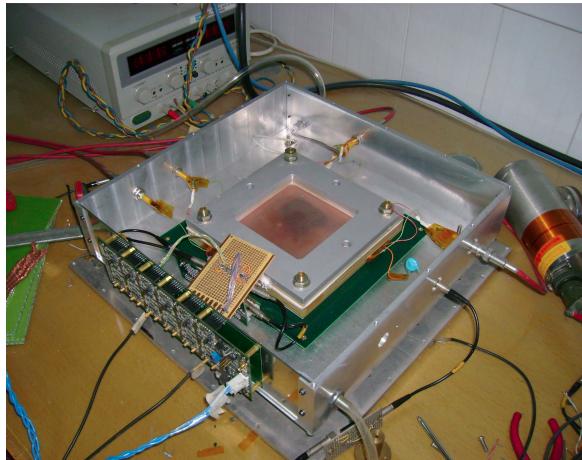




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Work on Small Area (10cm×10cm) GEM R&D



Position Resolution : $\sigma \sim 150\mu m$

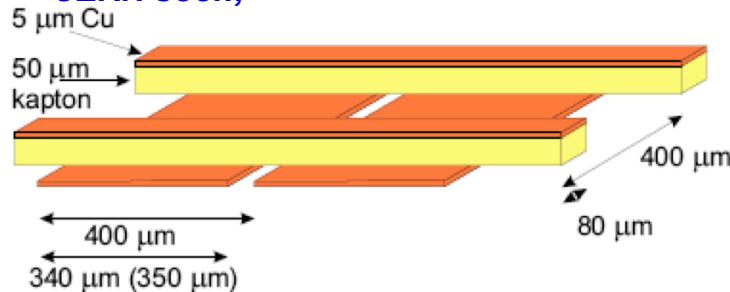


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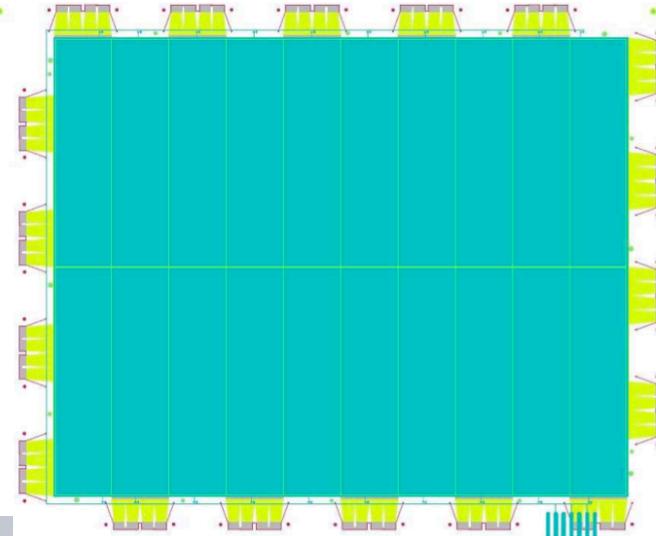
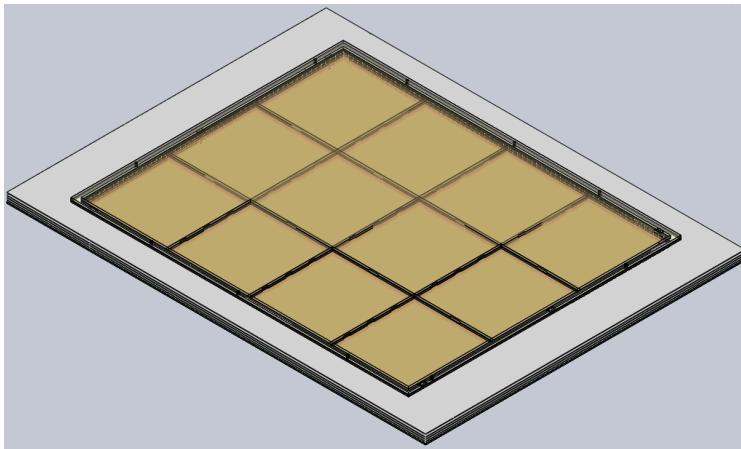
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Activity for Large Area GEM

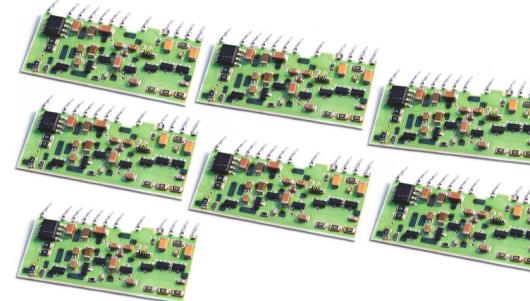
- ◆ Large GEM foils (40cm×50cm) and kapton readout anode will be got from CERN soon;



- ◆ Mechanical design for the GEM detector system has been started;



- ◆ Charge sensitive pre-amplifiers and flash ADCs are got, which can be used for the test of the basic detector performance (gain, efficiency, uniformity, etc) before we get the APV25 based electronics



Mar.-29-2011:
State key Laboratory of Particle Detection
and Electronics



- Build a large GEM ($40 \times 50 \text{ cm}^2$) detector;
- Set up the test stand (gas flow system, cosmic ray test platform, DAQ ...)
- Set up the electronics read out system with multi-channels (200 ~ 1000 channels)
- Build up models with different area (trapeziform GEM) needed for SOLID
- Beam test

Thank You