

# **GEM Progress From SOLID-GEM Chinese Collaboration**

**Jianbei Liu**

**University of Science and Technology of China**

**SOLID Collaboration Meeting**

**May 15, 2015**

**JLab**

# SOLID-GEM Chinese Collaboration

**China Institute of Atomic Energy**

**(CIAE)**



**Lanzhou University**



**Institute of Modern Physics, CAS (IMP)**



**中国科学院近代物理研究所**

Institute of Modern Physics, Chinese Academy of Sciences

**Tsinghua University**



**清華大學**  
Tsinghua University

**University of Science and Technology of China (USTC)**



**中國科學技術大學**

University of Science and Technology of China

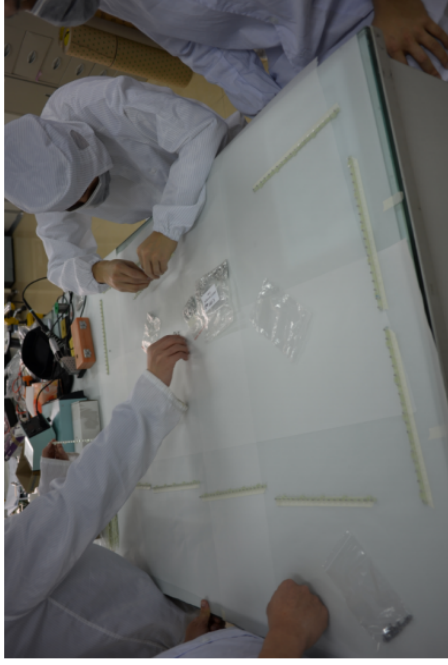
# Progress From USTC

- Large-area GEM prototyping
- AVP25-MPD readout
- GEM readout R&D

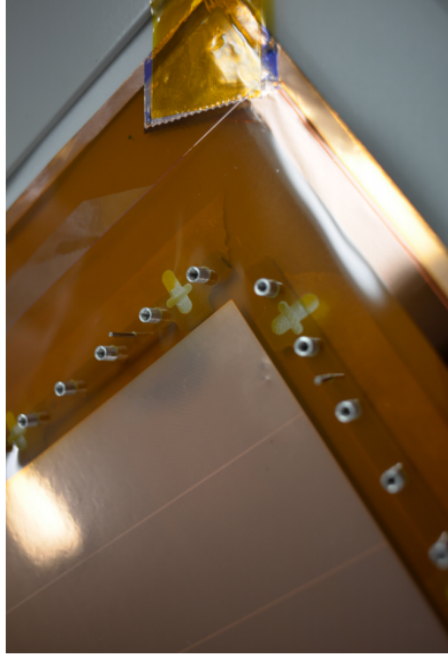
# A Large-area GEM

- Designed and built a **1m\*0.5m** GEM prototype

Assembling the inner frame



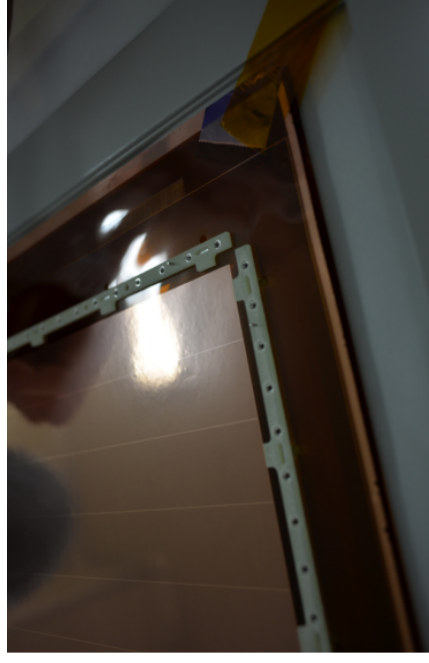
Placing the first GEM foil



Placing the second GEM foil



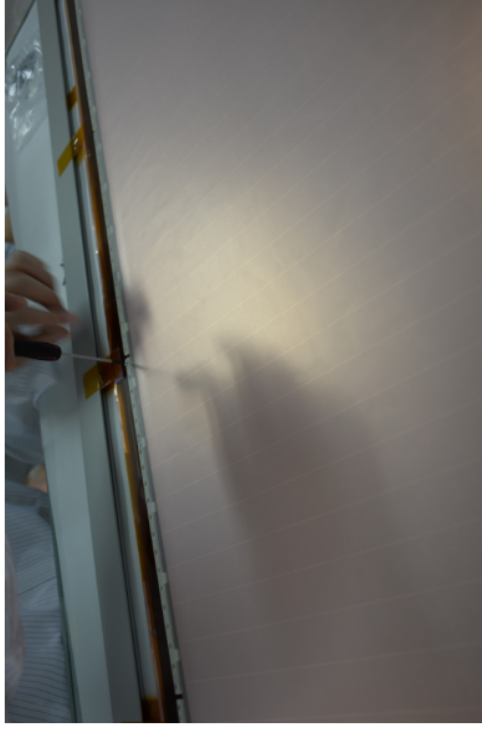
Mounting the embedded nuts



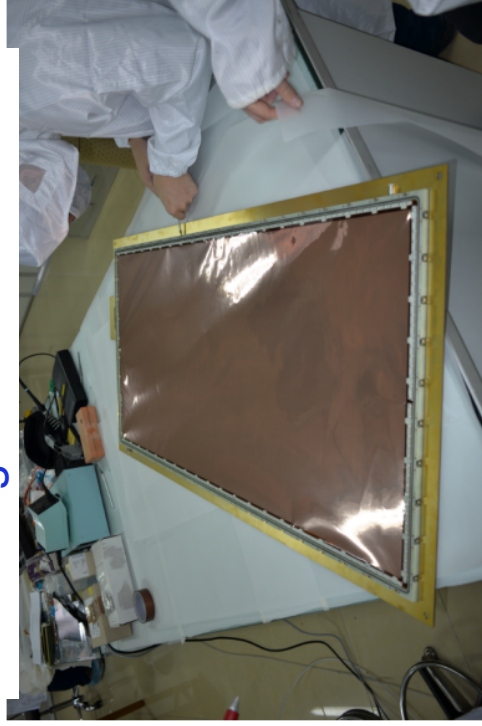


# Continued

Fixing the three GEM foils



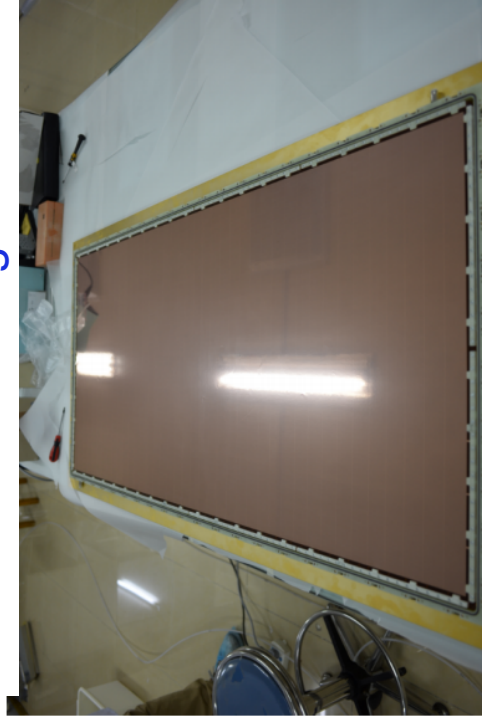
Stretching the GEM foils



Cutting off the GEM edges

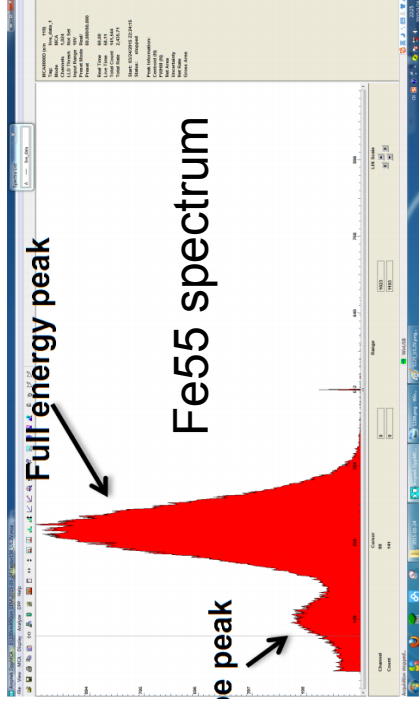
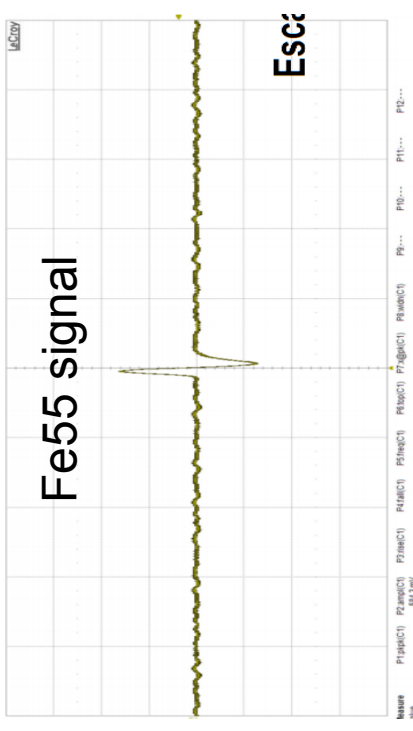
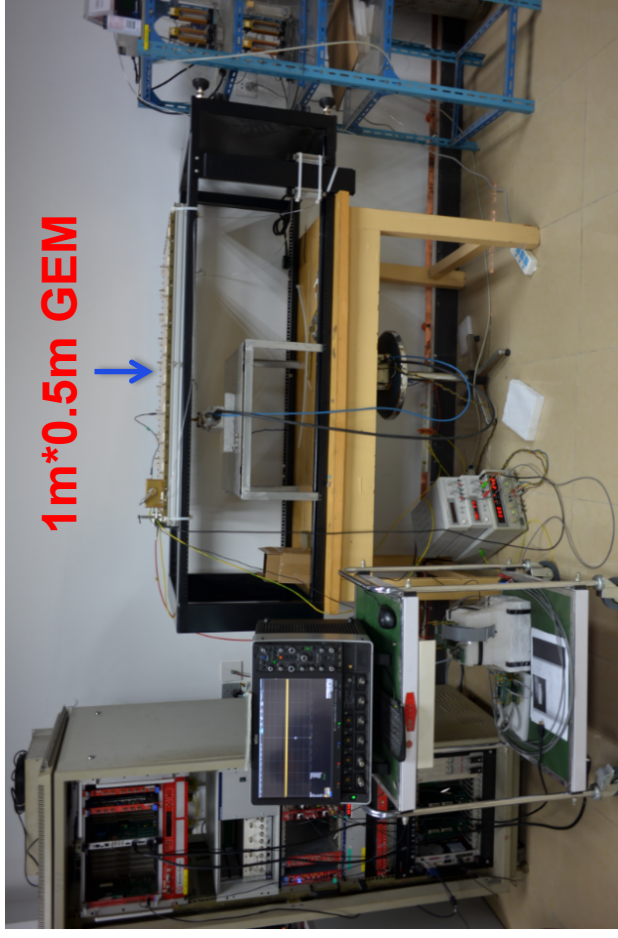


GEM assembling finished



A 1m\*0.5m **GEM** chamber

# GEM Testing



- Tested the 1m\*0.5m GEM prototype with Fe55
- Energy resolution ~ 22%

# GEM Stretching Platform

- Built a stretching platform instrumented with tension monitors, dedicated to large-area GEM stretching.
- To study how to best stretch large-area GEMs
  - Tension segmenting
  - Optimizing NS2 technique

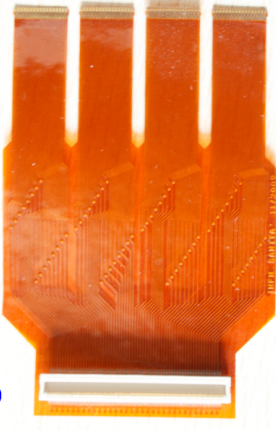




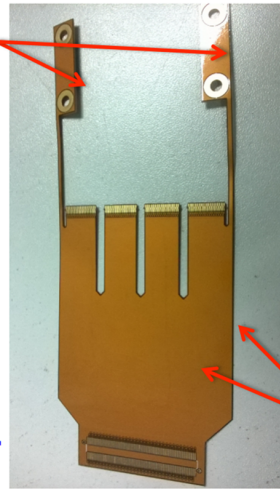
# APV25-MPD Readout

- Redesigned the FPC connector of APV25 hybrid to improve the grounding so as to reduce noise.
  - Added two ground planes providing good shielding for signals
  - Added four ground vias enhancing ground connection between APV25 and detectors

Original version



Improved version



Ground planes on top and bottom layers

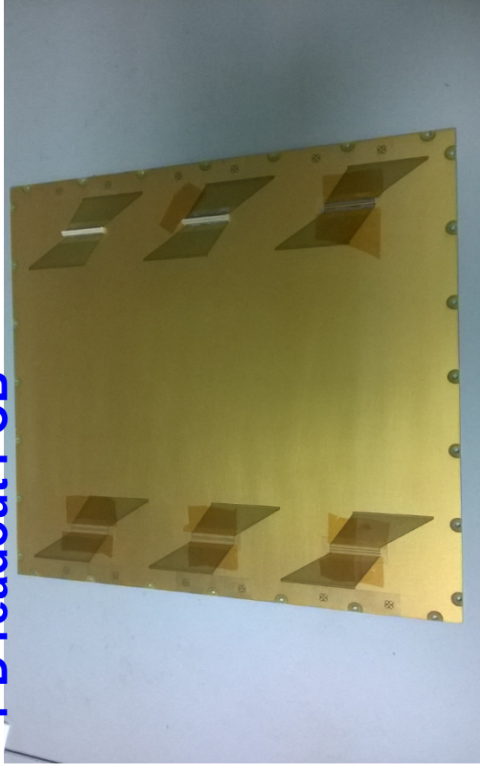
- The whole readout system has been set up and is being tested with the help from CIAE



# GEM Readout Boards

- We have prepared two readout boards for testing GEM positioning performance.
- The tests will be done with the APV25-MPD readout system.

1-D readout PCB



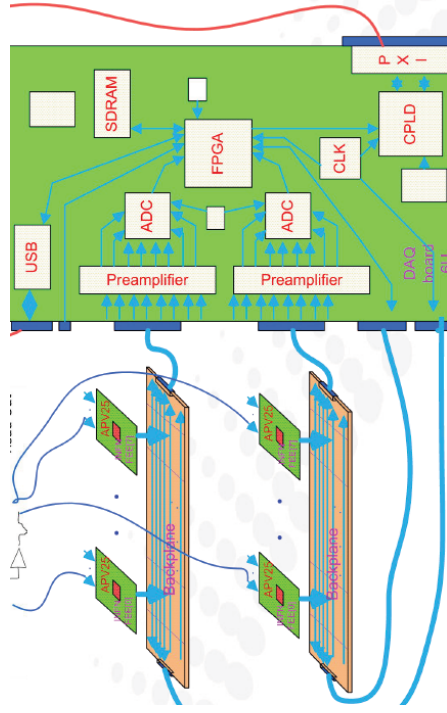
2-D readout PCB



# GEM Readout R&D

- Developed a GEM readout system based on the INFN APV25 hybrid.
- Testing and characterizing the readout system.

**GEM readout system developed at USTC**



**Testing the system**

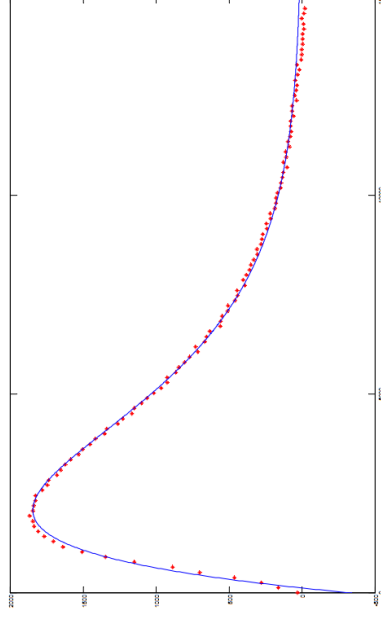


# Preliminary Testing Results

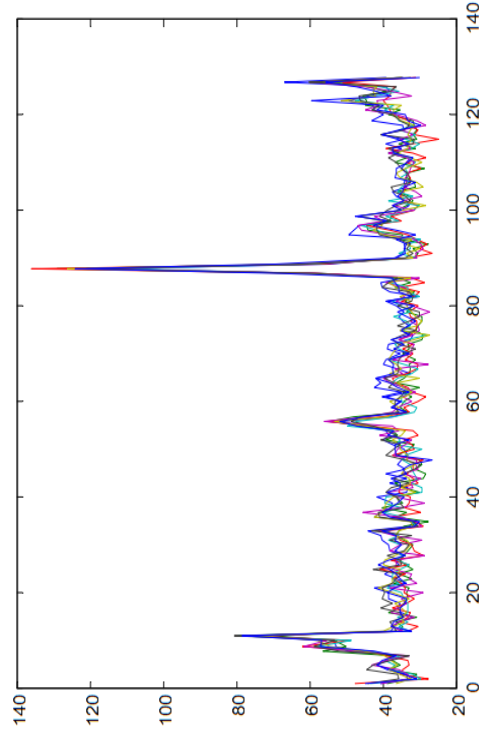
Noise test

connector adatper	connector adatper charge board	connector adatper charge line	connector	No connector
49.70	99.40	79.39	64.29	11.69
2468e-	4939e-	3944e-	3193e-	579e-

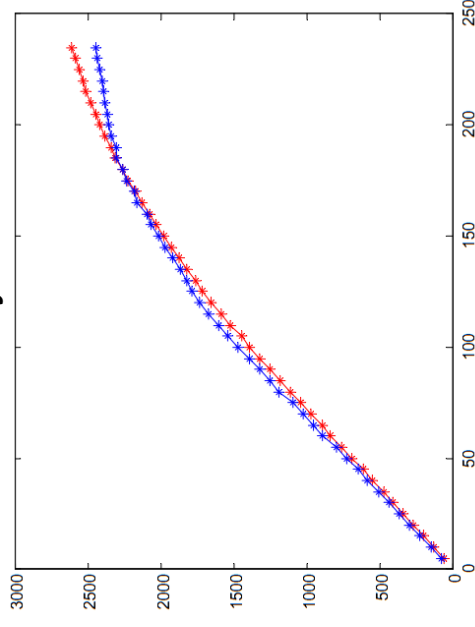
Calibration waveform



Noise in different channels



Linearity test

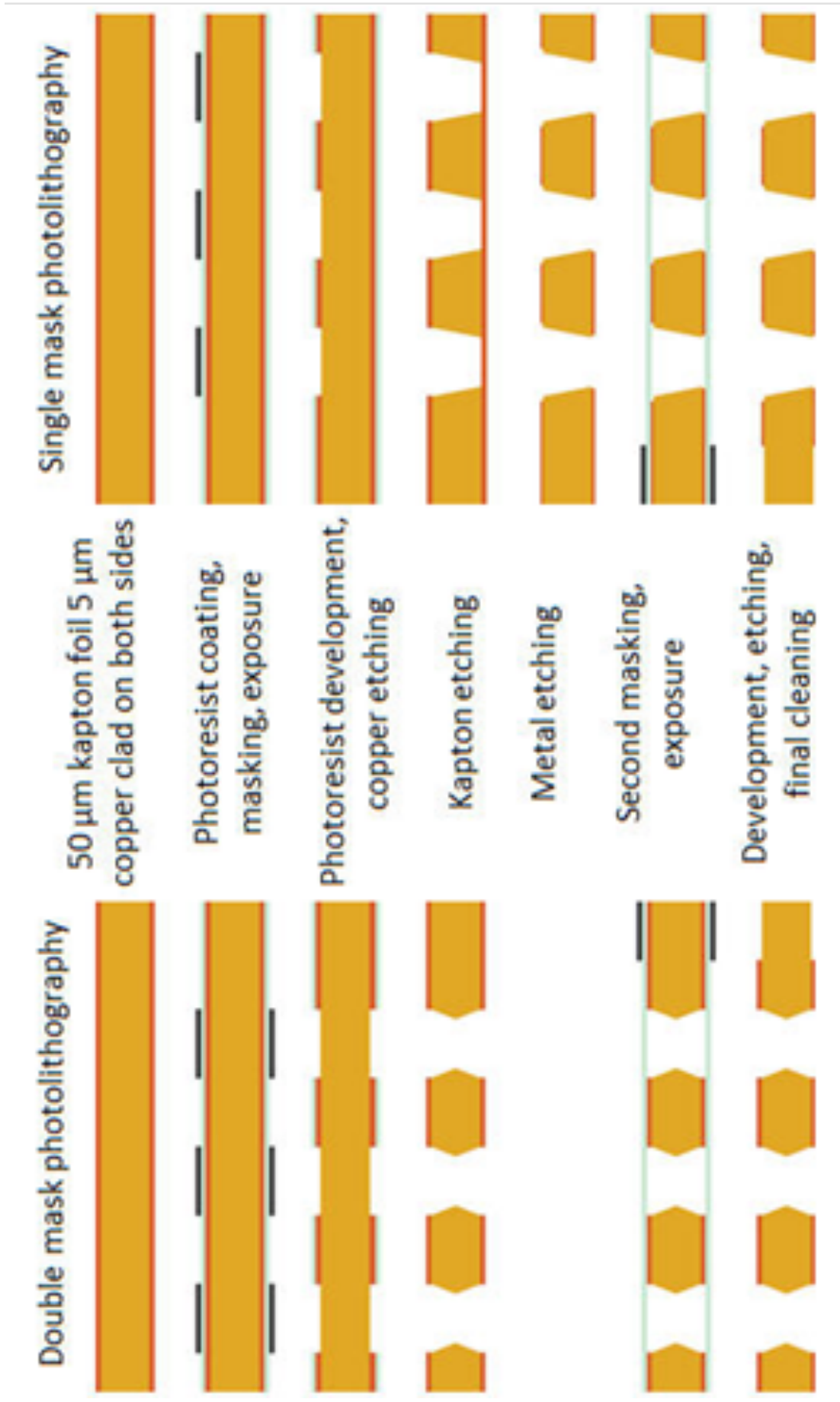




# Progress From CIAE

- GEM foil production using single mask technique

# Procedures of GEM Foil Production

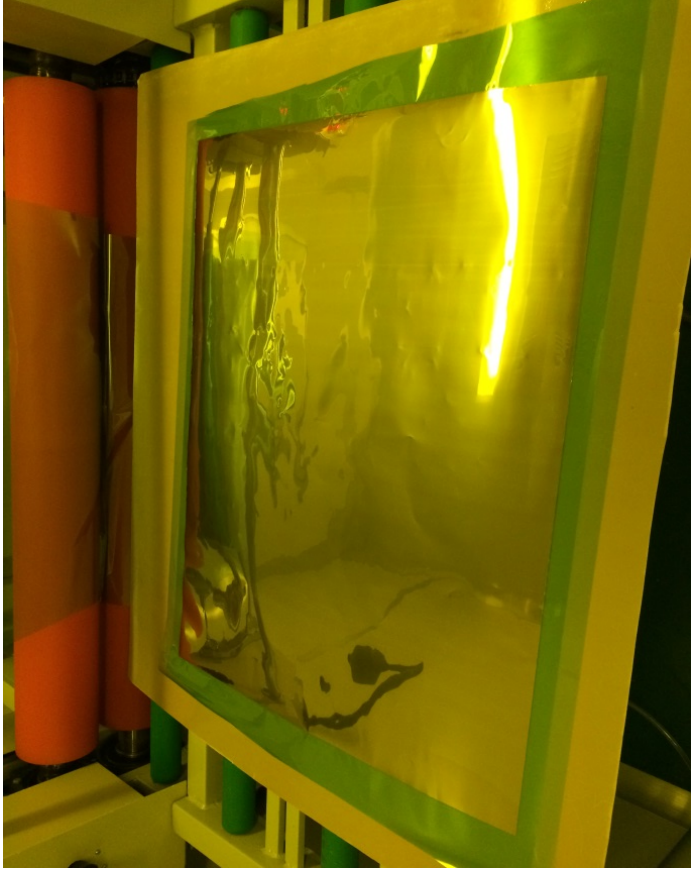


# GEM Photo Mask Plate



The copies of the photo-mask are done by photolithographic techniques. 40cm\*40cm photo mask is produced.

# Lamination of Dry Film Photoresist

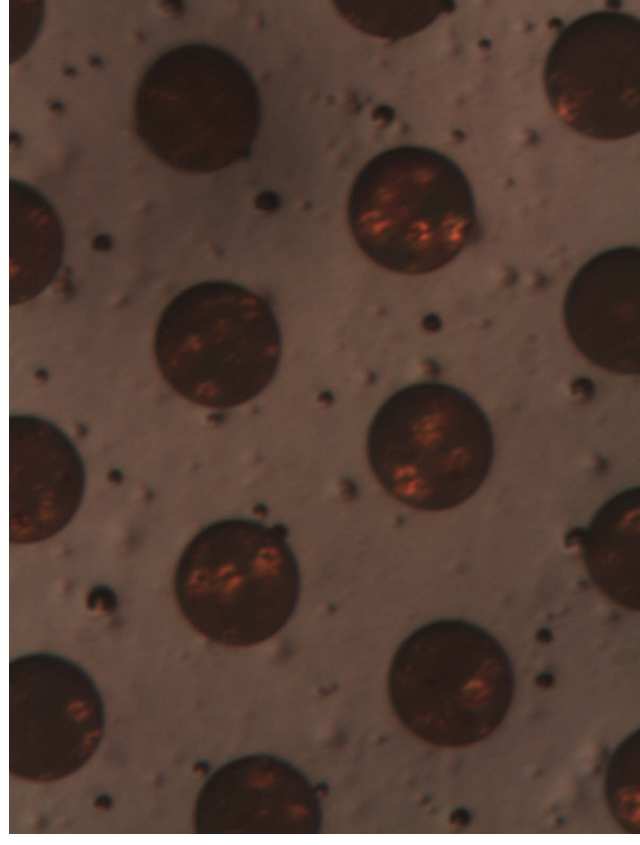
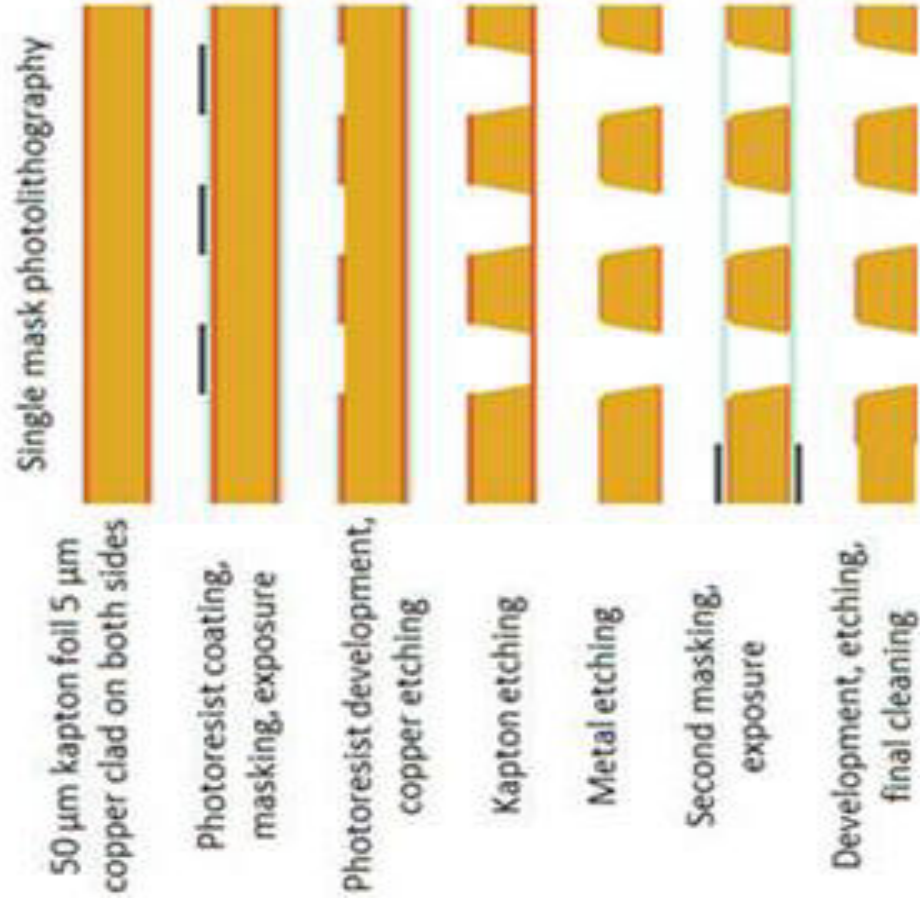


# Exposure of Dry Film Photoresist

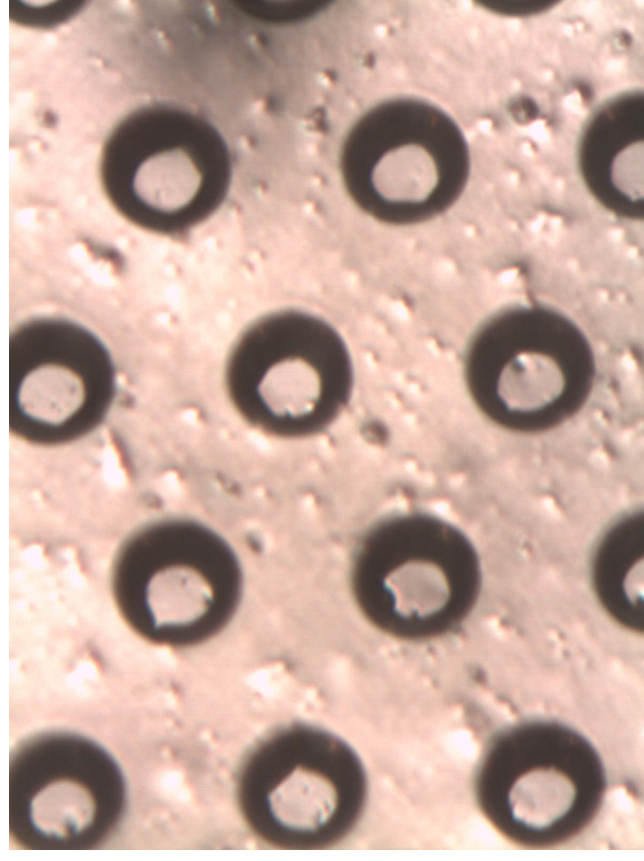
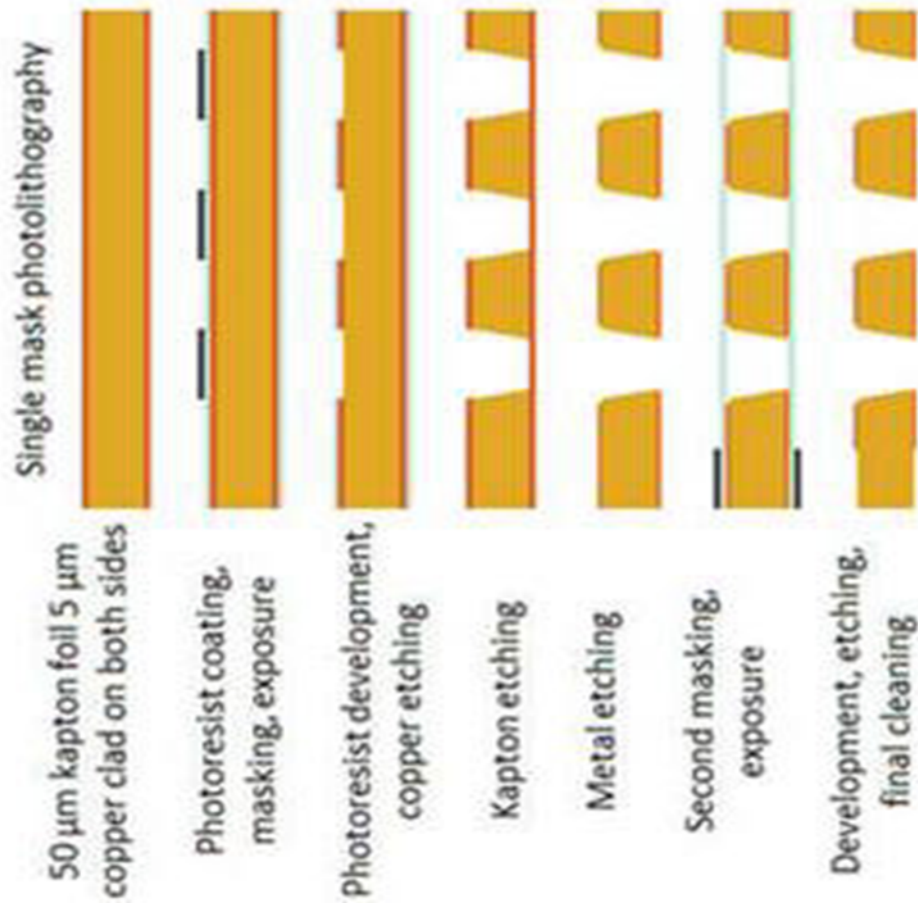




# After First Copper Etching

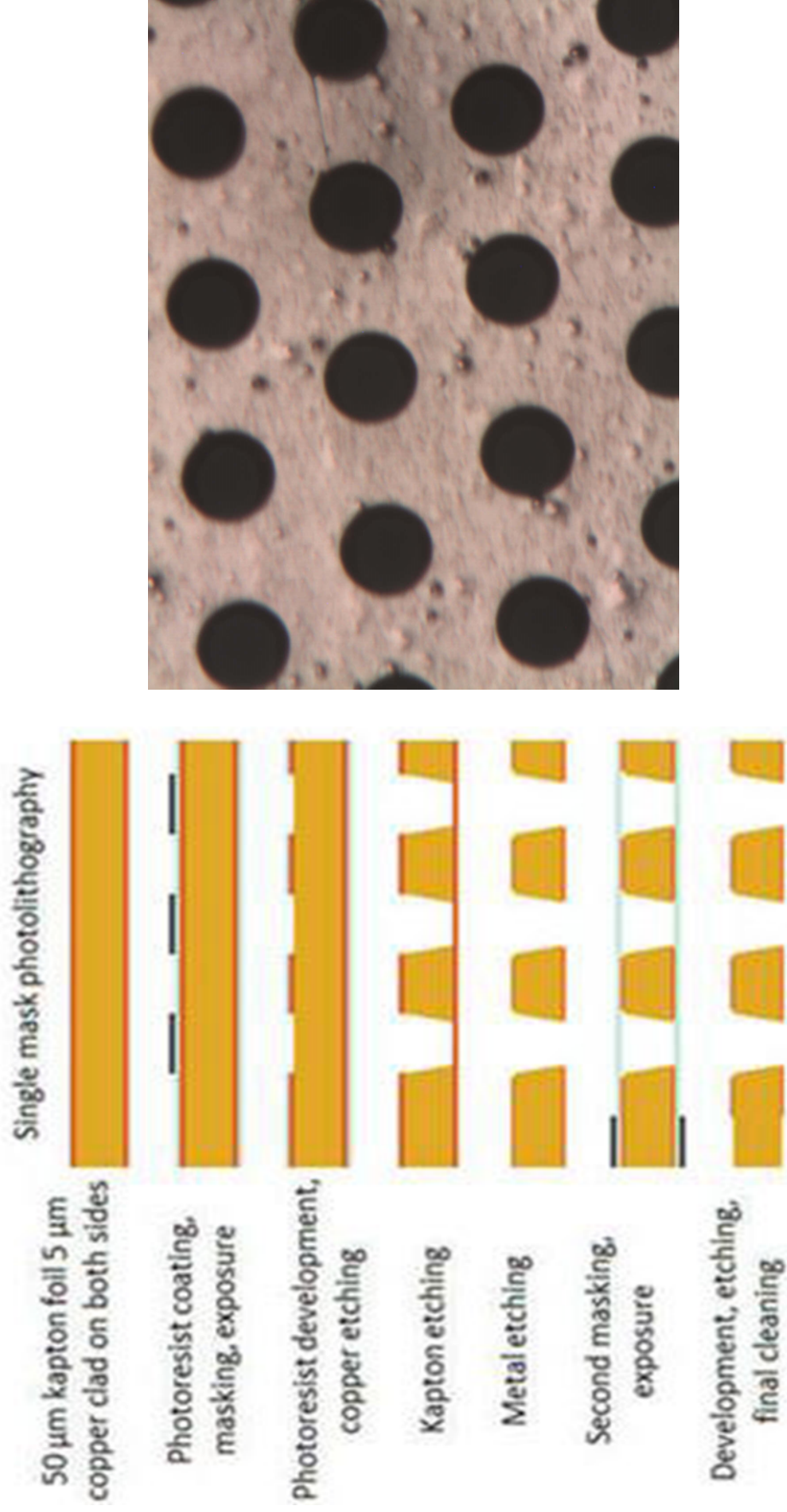


# After First Kapton Etching





# After Second Copper Etching



# 40cm\*40cm GEM Foil

- The 40cm\*40cm GEM foils were made successfully at CIAE.
- Single-mask method was used.
- Next step: Improve the rate of finished products.



# Summary

- Big progress in large-area GEM chambers  
~0.5m\*1m
- Testing and characterization of GEM readout
- Breakthrough on single-mask GEM foil  
production ~40cm\*40cm