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The Progress of GEM foil at CIAE

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on Nuclear Data Laboratory

China Institute of Atomic Energy

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Outline

- The progress of GEM foil at CIAE
- Other developments

The Progress of GEM Foil at CIAE

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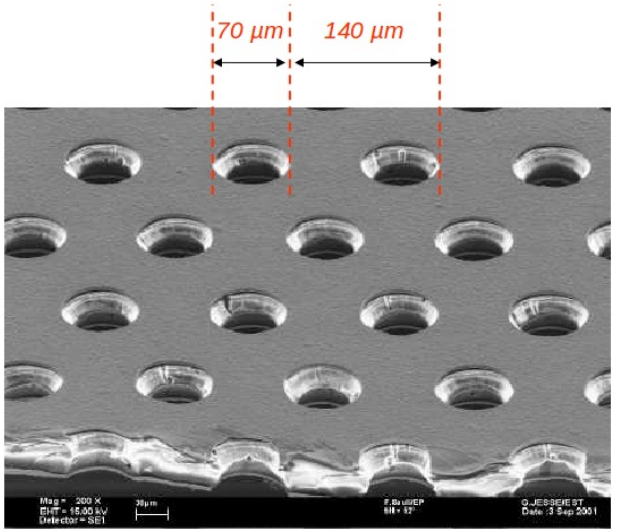
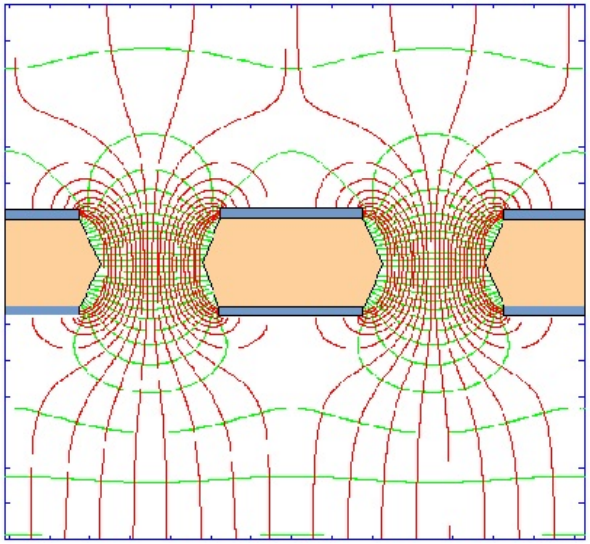
GEM Foil Structure

1. Typical GEM Foil has 3 layers, two 5µm thick copper foils and one 50µm thick kapton foil in the middle.
2. Diameter of the hole is 70 µm , and the distance between them is 140 µm .
3. Apply electric voltages on the two copper layers.
4. Electric Field is very strong in the hole area, and weak outside the hole area.



GEM Foil



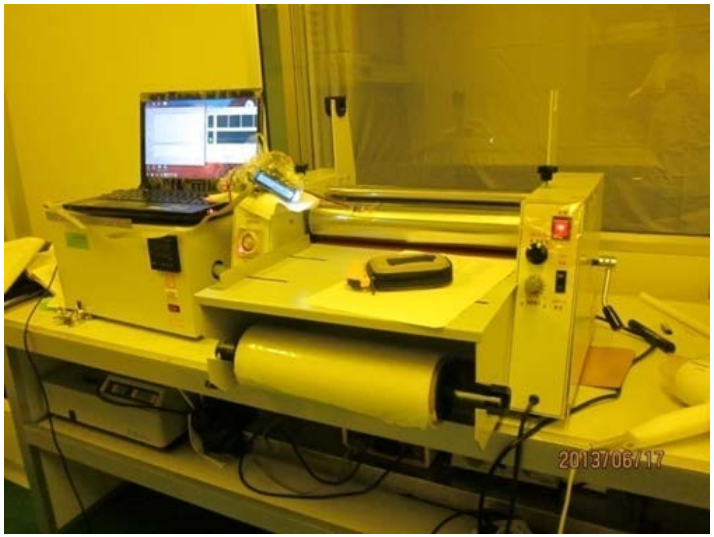
GEM Field

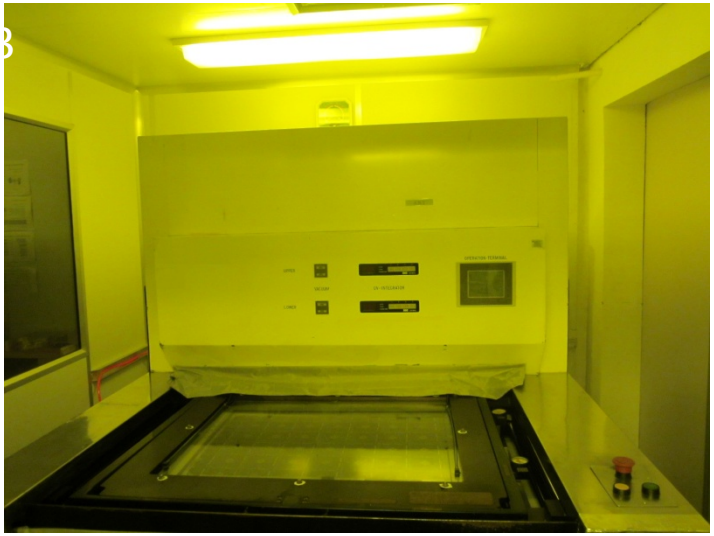
Clean Room

The cleanrooms at China Institute of Atomic Energy are ISO Class 6.

Photolithography Lab Construction At CIAE

The Equipments for Lamination and Exposure of Dry Film Photoresist





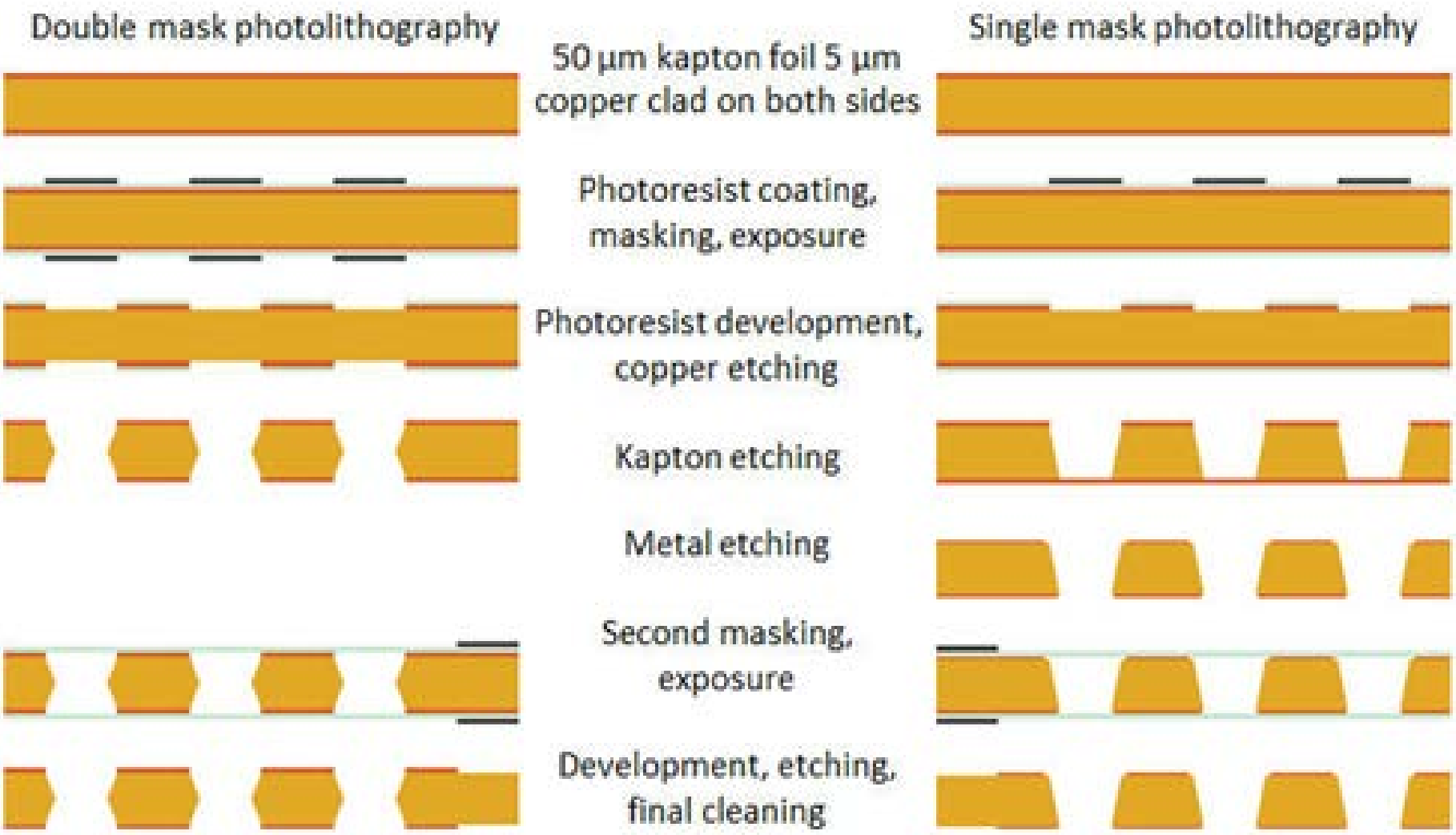
Lamination and exposure of dry film photoresist are the most important and difficult steps for GEM foil production.

We have established a yellow light zone, and have introduced Hot Roll Lamination (HRL) machine and Exposure system.

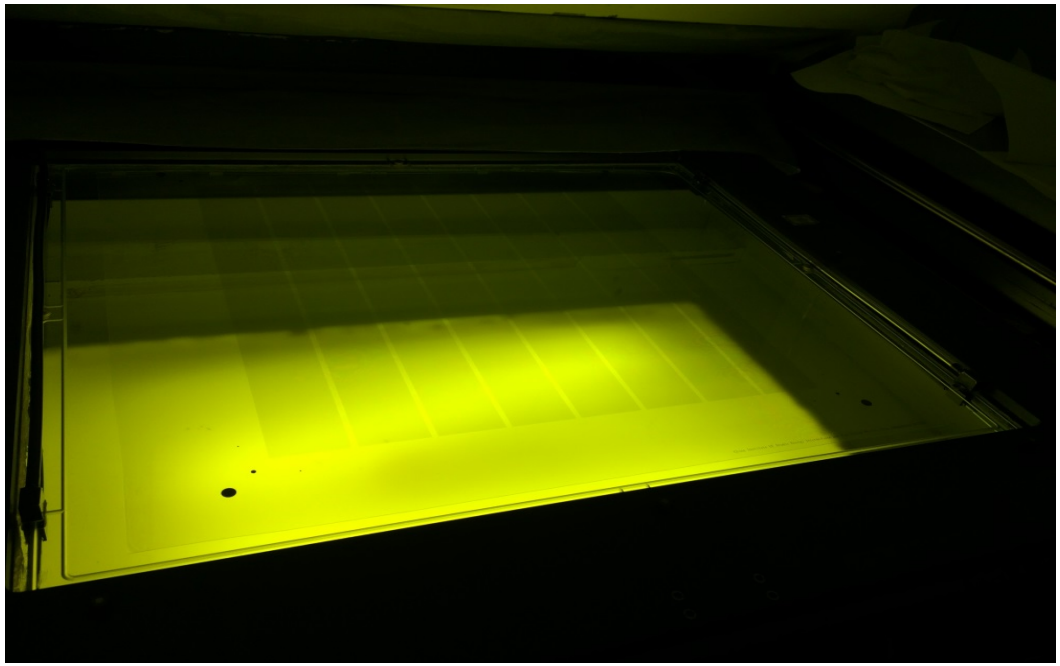
We invited the Senior engineer from a famous electronic factory to CIAE and teach the PCB technology.

Etching Room Construction

The Procedure of GEM Foil

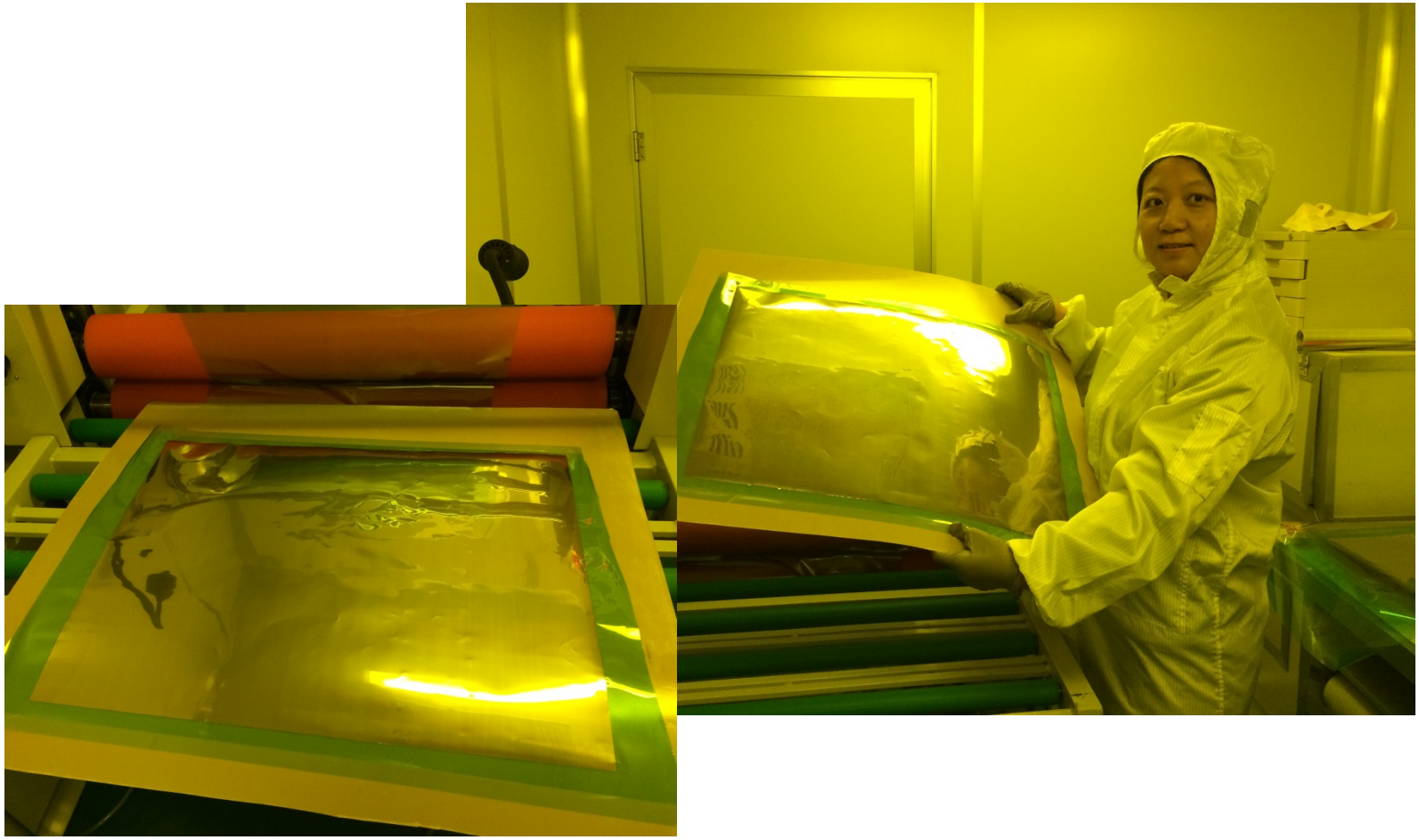


GEM Photo Mask Plate



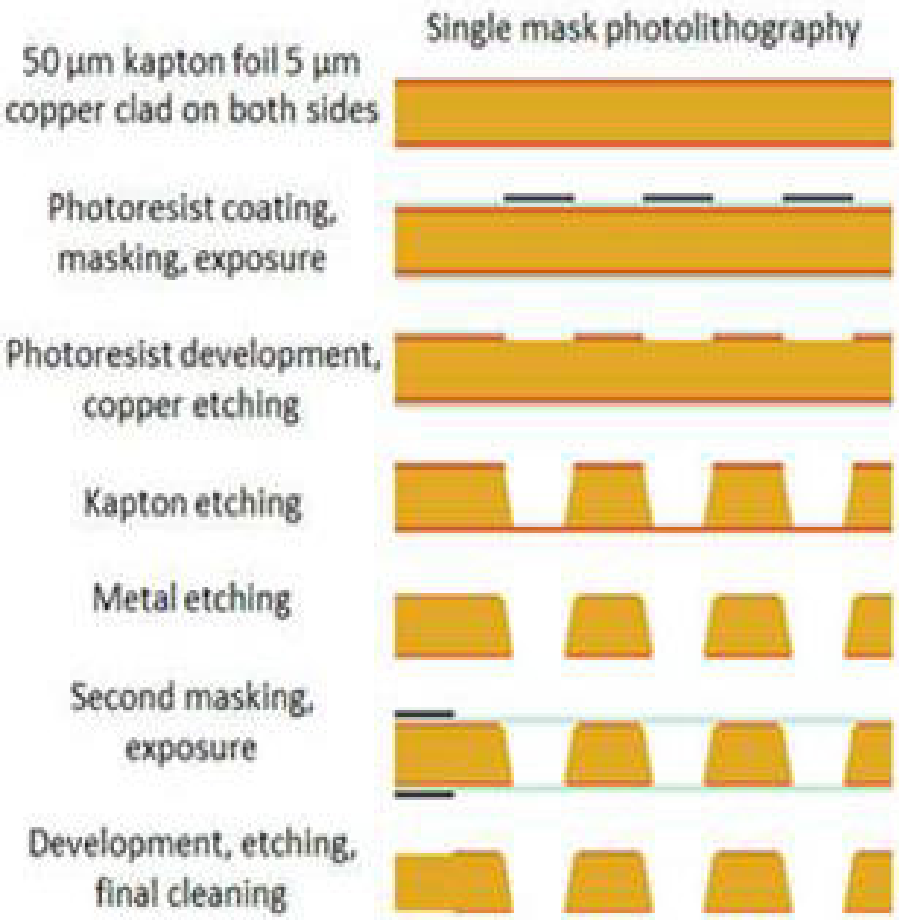
The copies of the photo-mask are done by photolithographic techniques.
40cm*40cm photo mask is produced.

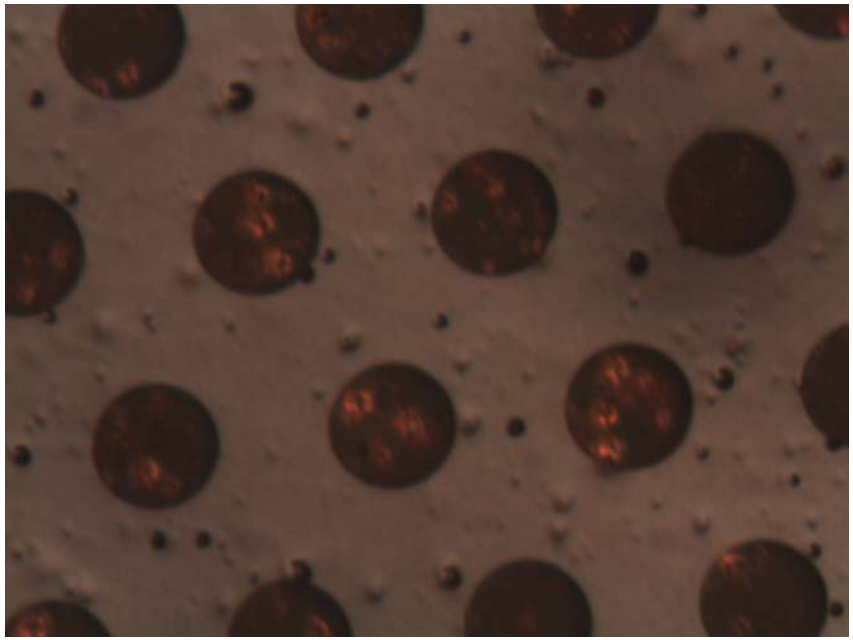
Lamination of Dry Film Photoresist



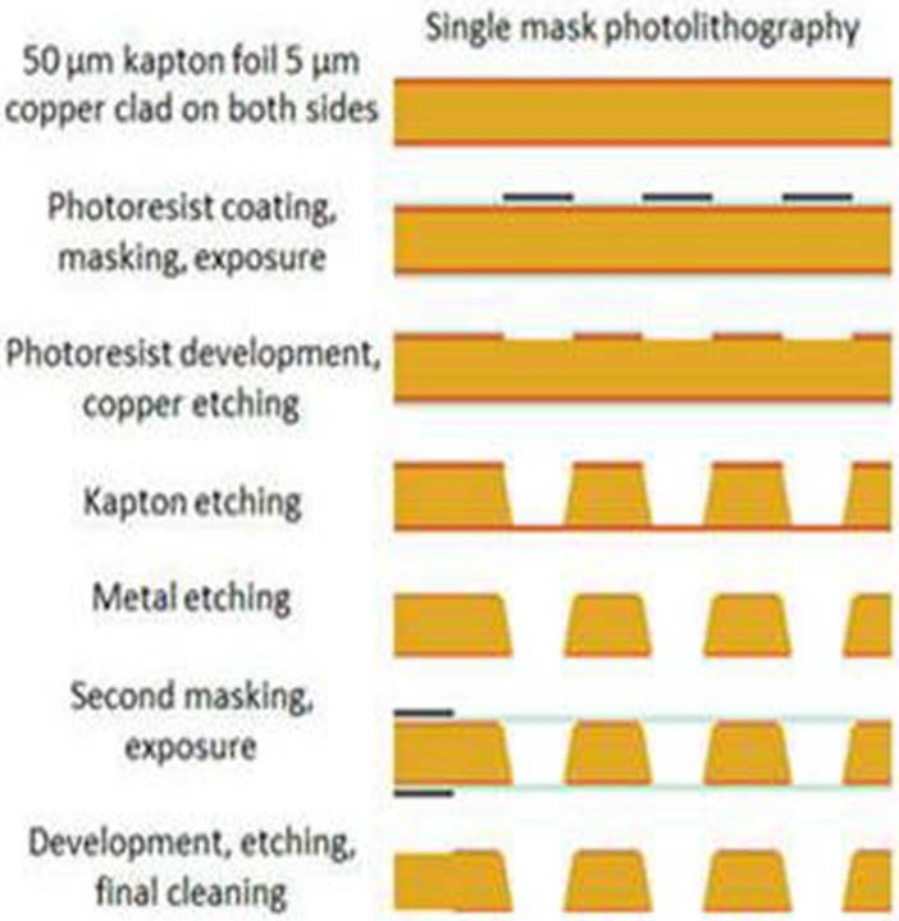
Exposure of Dry Film Photoresist

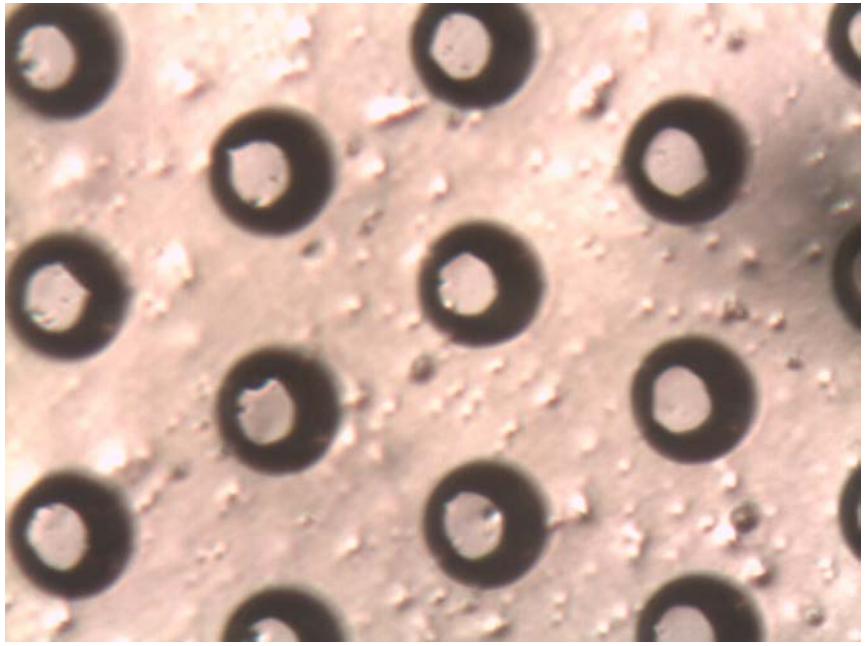
After First Copper Etching



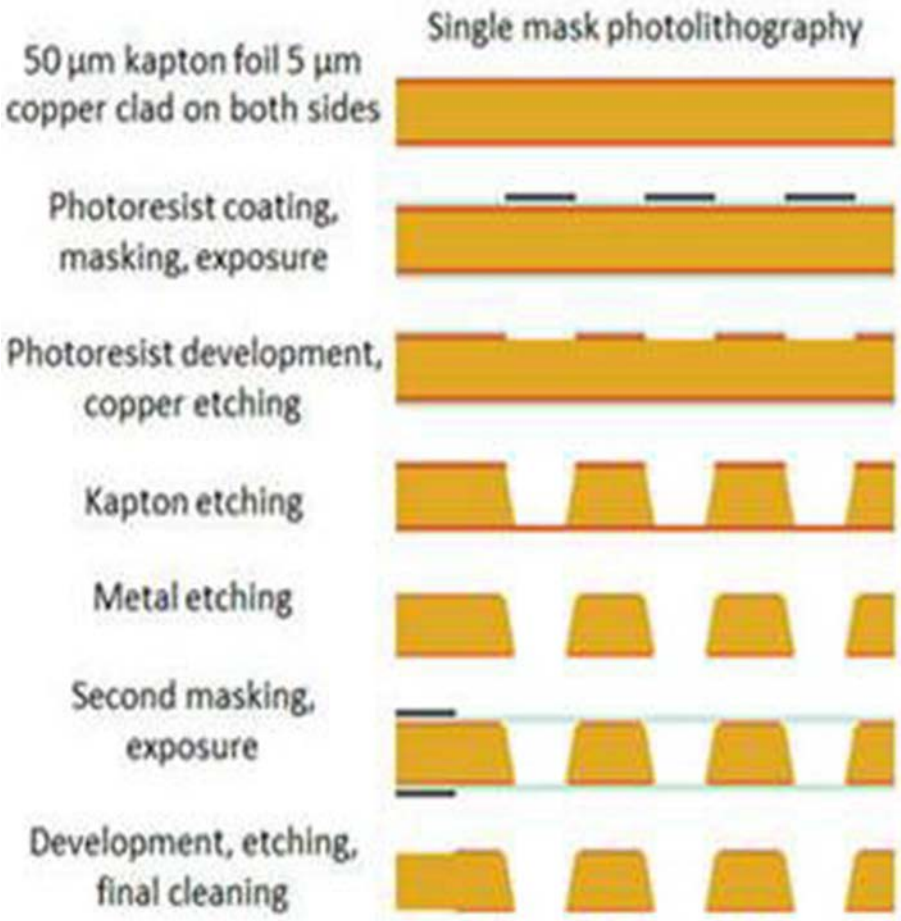


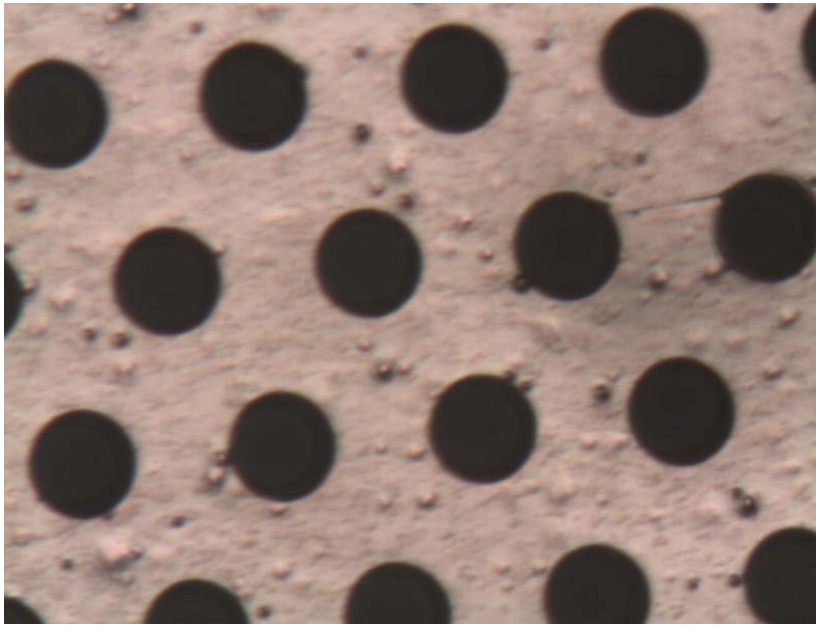
After First Kapton Etching



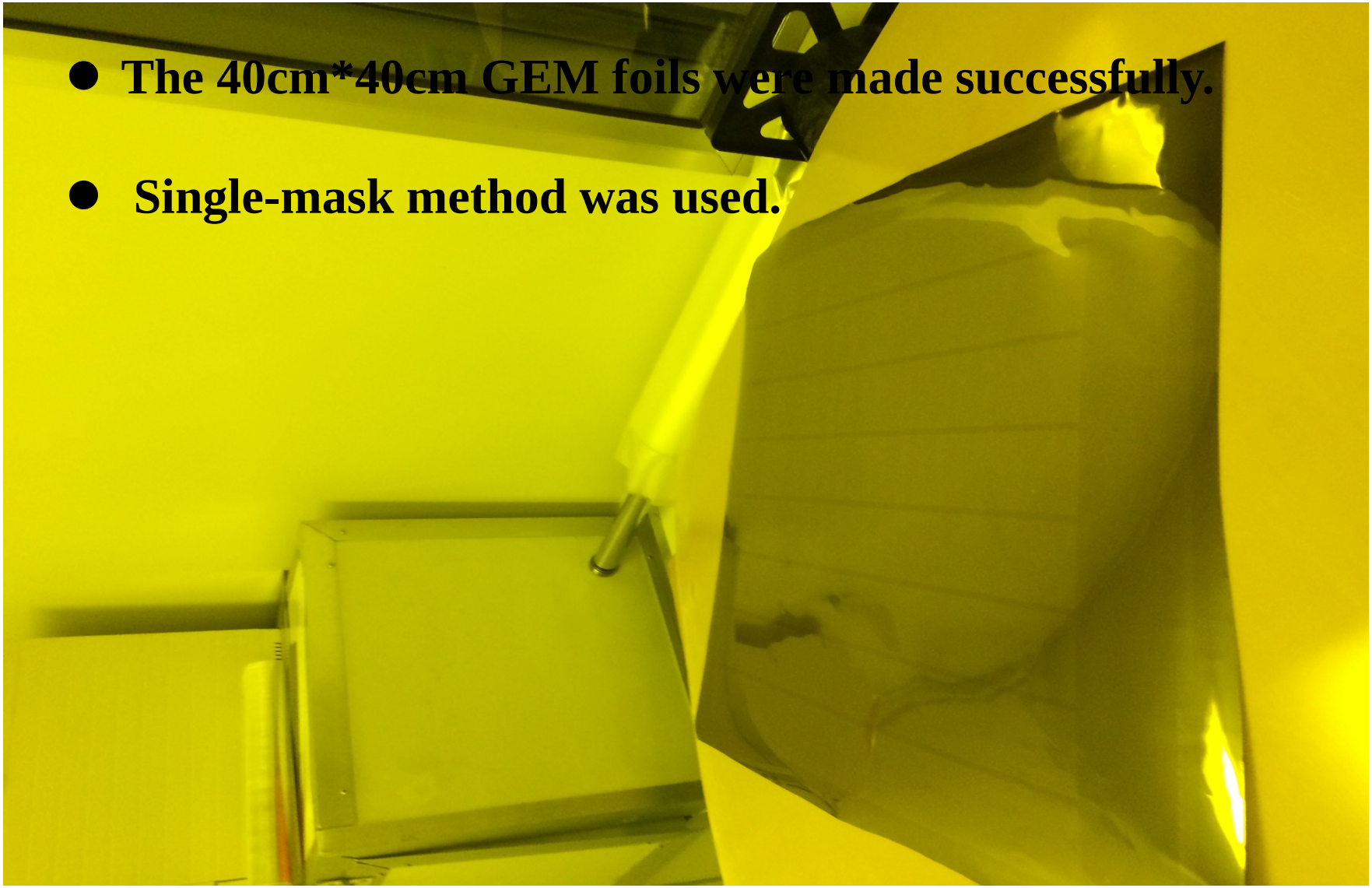


After Second Copper Etching



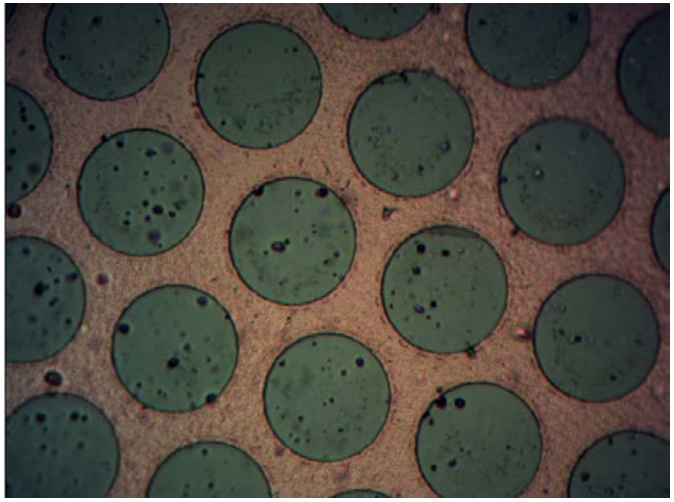


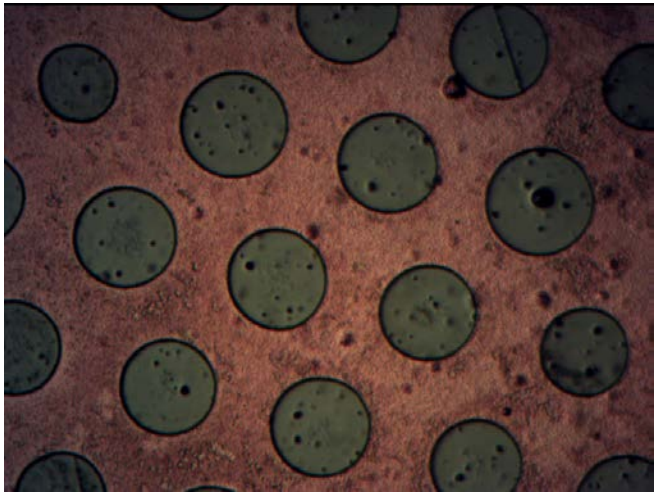
40cm*40cm GEM Foil

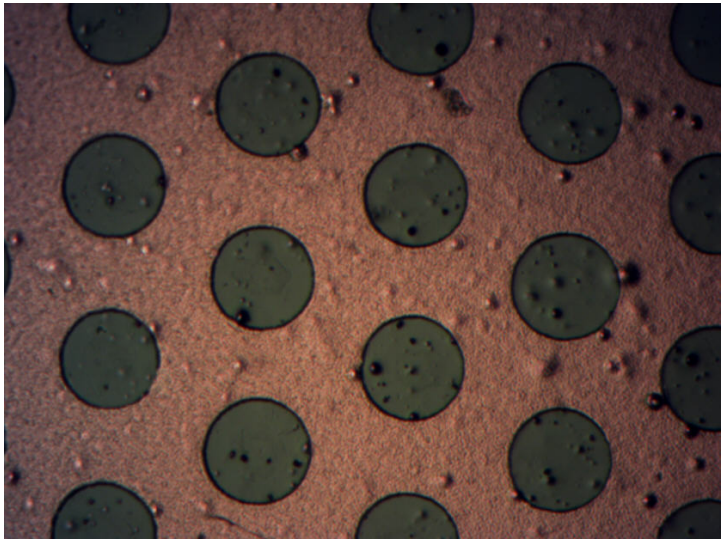


- **The 40cm*40cm GEM foils were made successfully.**
- **Single-mask method was used.**

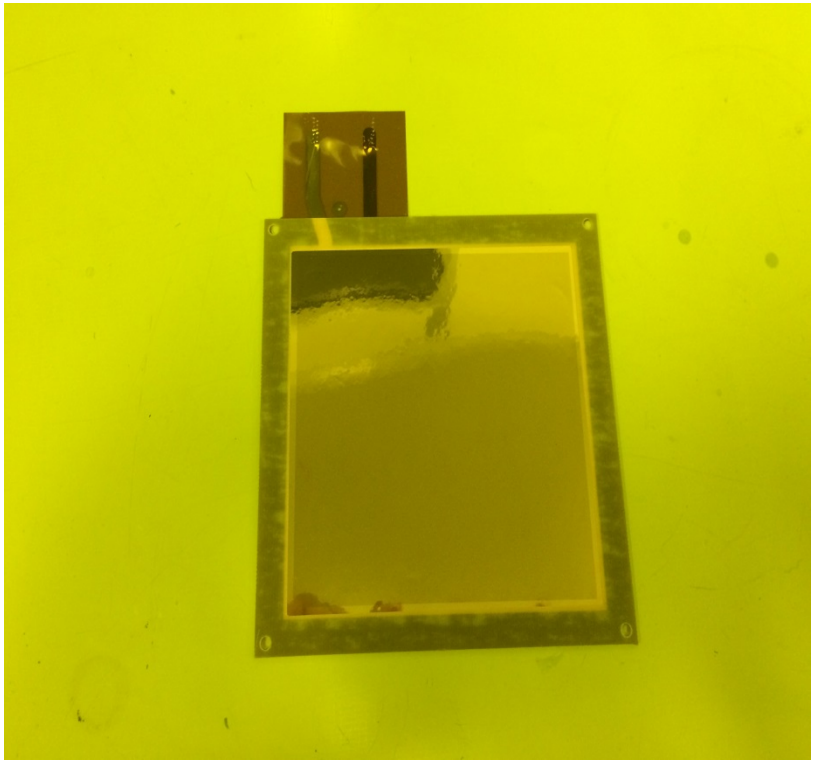
New Chemical Reagents

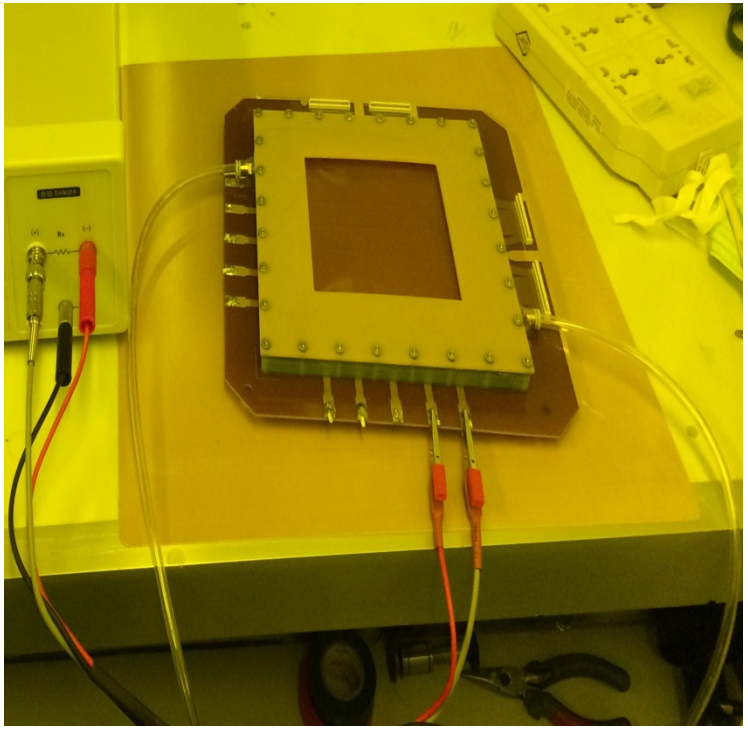






Test





Other Developments

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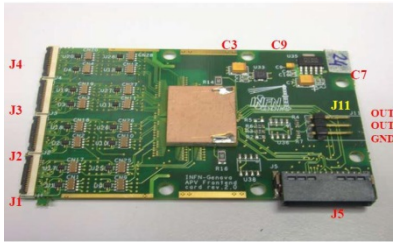
GEM Test system with APV25 Electronics



VME crate

V2718

MPD

Control signal

Optical fiber

APV25 FEC

Analog signal

REST

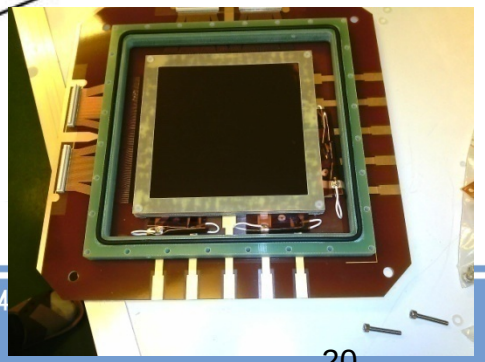
TRIGGER

GEM Detector

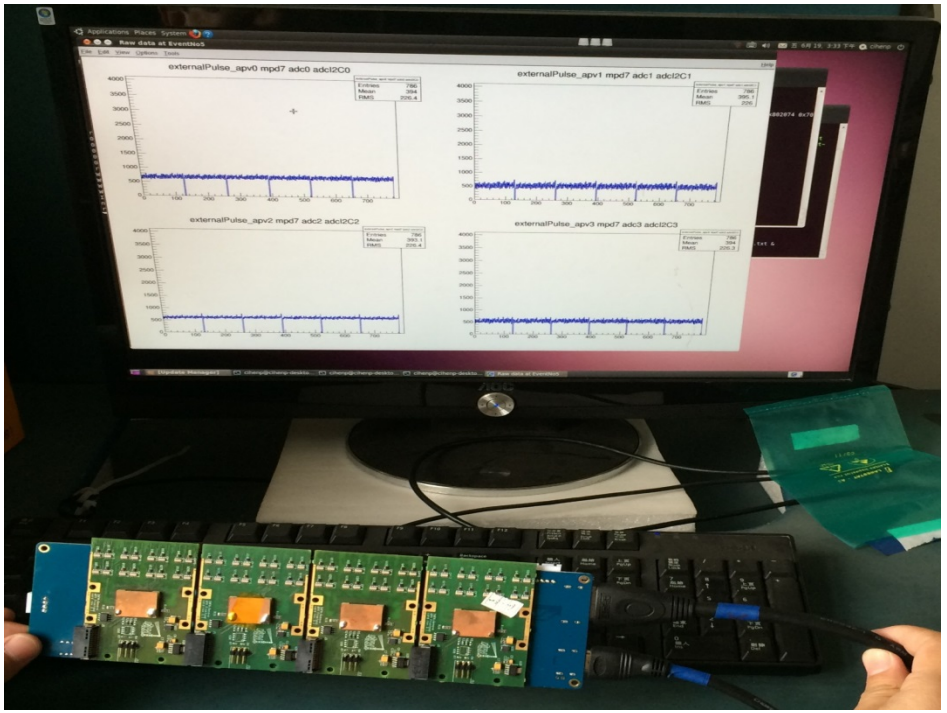
HV

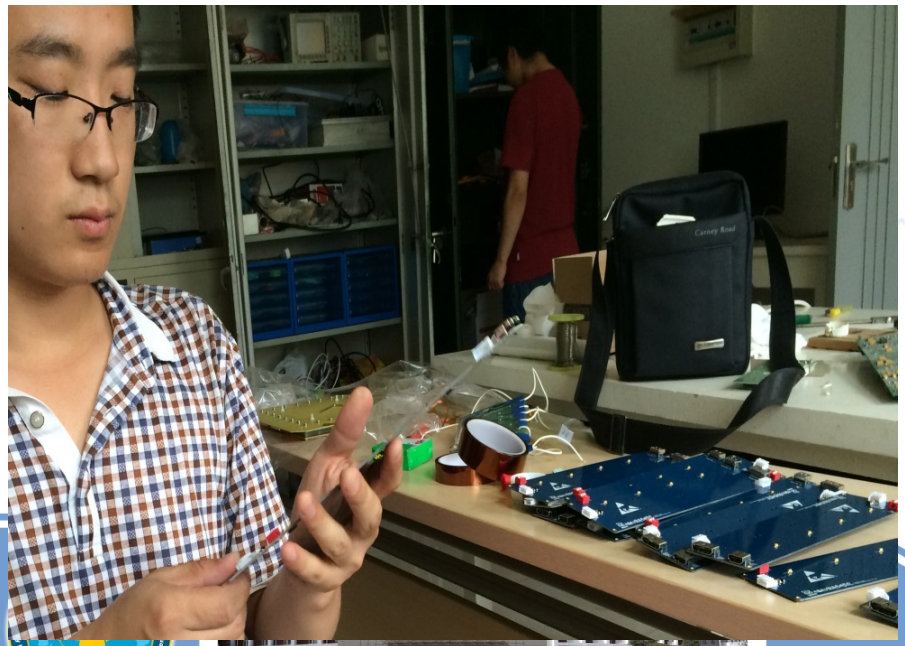
LOGIC UNIT

DISCRIMINATOR



R&D of BackPlane



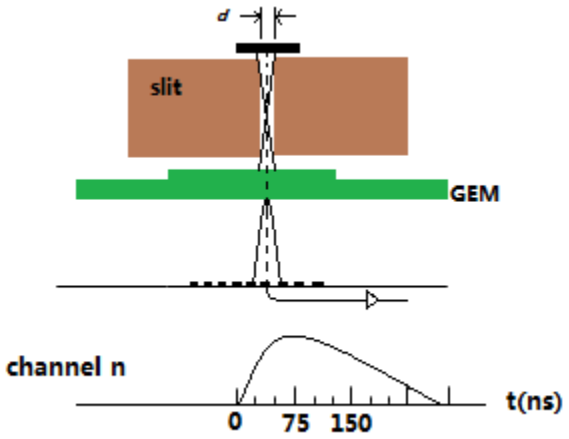


Spatial resolution

$$\sigma_{tot}^2 = \sigma_{GEM}^2 + c_1\sigma_{geometry}^2$$

When: $\sigma_{geometry} \ll \sigma_{GEM}$

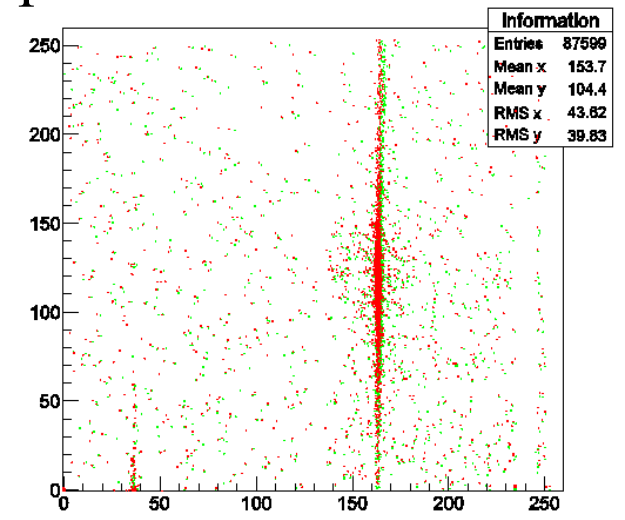
$$\sigma_{tot}^2 \cong \sigma_{GEM}^2$$



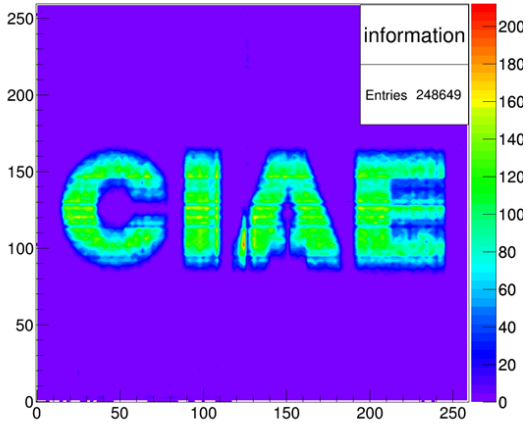
- **Slit(um): 20;**
- **Ar: CO_2=70% : 30%;**
- **HV: 3600V;**
- **The distance between strips: 400um;**

ε=19.6%

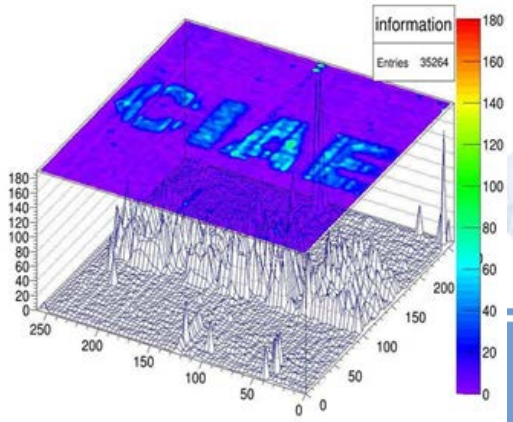
Spatial resolution≈76um



X-ray imaging @ CIAE

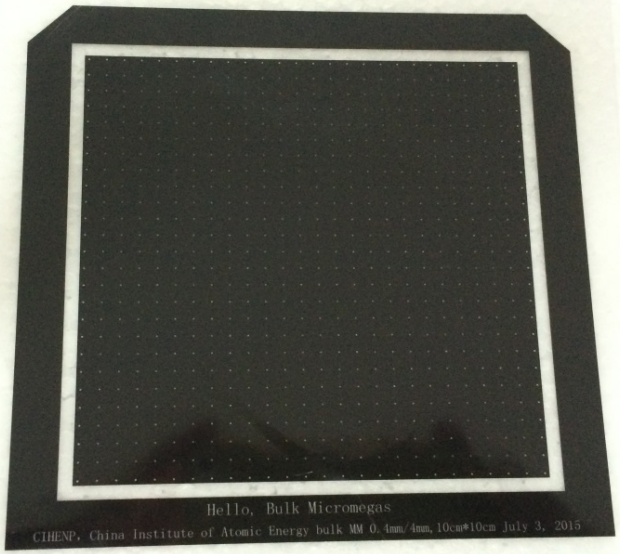


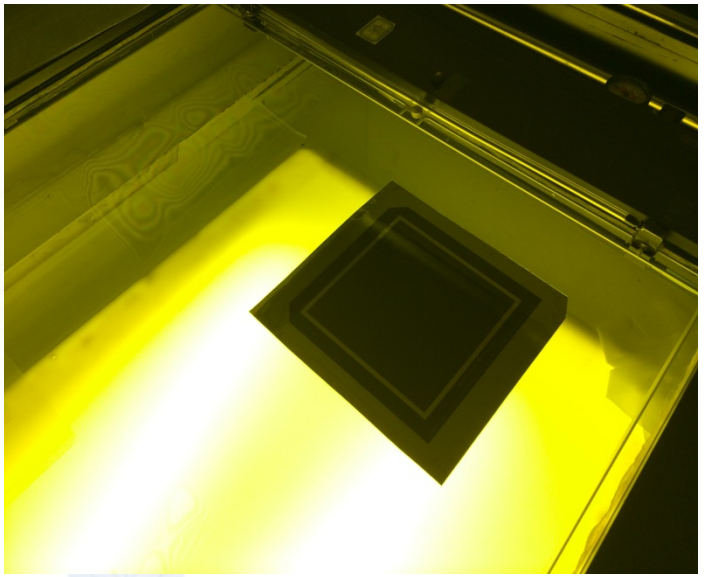
- X ray Energy: 8.9KeV;
- about 1k sample rate
- 256 channels for each dimension(512 channel in total);
- 4 APV FECs were used (2 for each dimension)



R&D of Bulk MicroMegas

Based on the Collaboration with CEPC TPC (IHEP)





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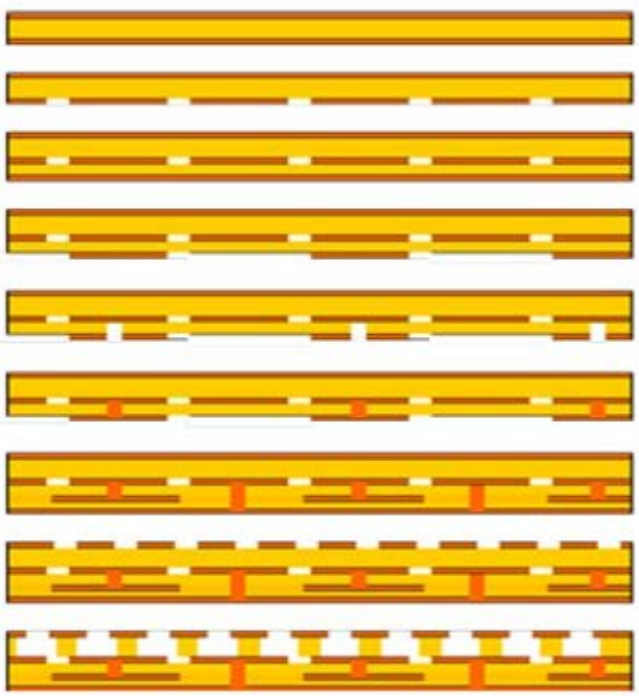
R&D of MicroBulk MicroMegas

Microbulk Micromegas Fabrication Process

This technology is inspired by
the GEM detector fabrication process invented at CERN .



Double side Cu-coated (5 μm) Kapton foil (50 μm),

Construction of readout strips/pads (photolithography)

Attachment of a single-side Cu-coated kapton foil (25/5 μm)

Construction of readout lines

Etching of kapton

Vias construction

2^{nd} Layer of Cu-coated kapton

Photochemical production of mesh holes

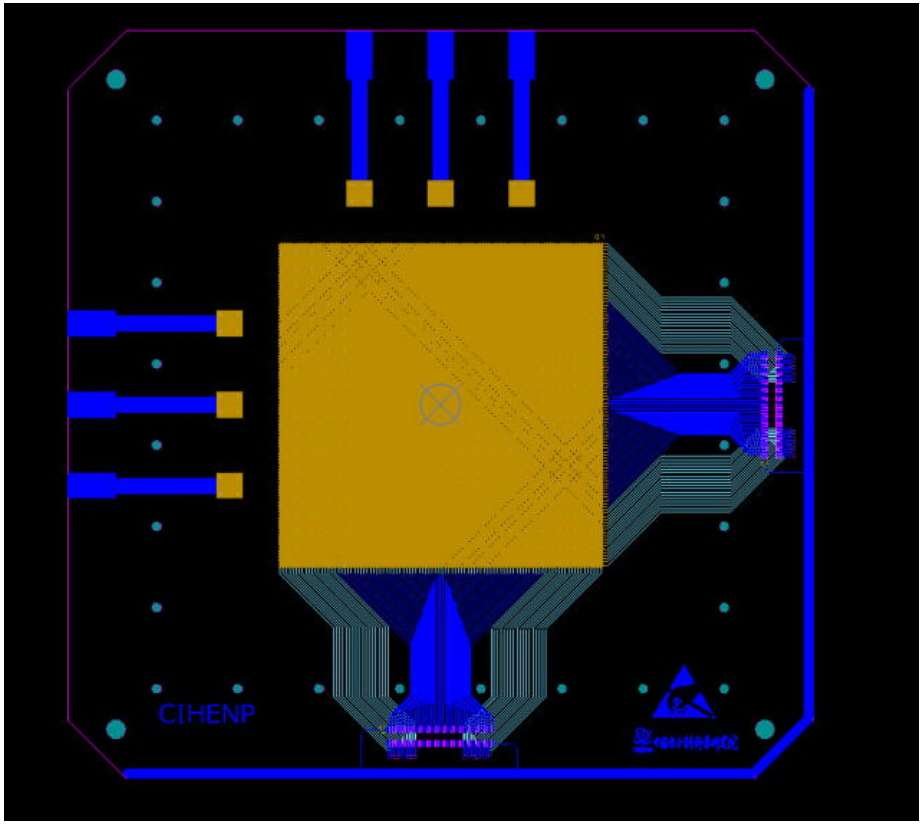
Kapton etching / Cleaning

Current Work on MicroBulk MicroMegas

Based on the Collaboration with PANDAXIII(SJTU)

New design of 10cm*10cm MicroBulk MicroMegas

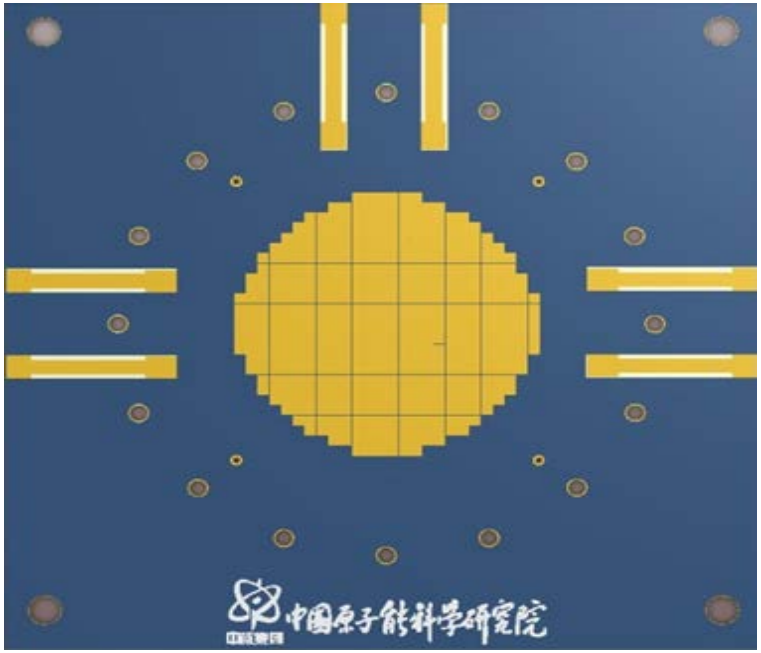
Prototype: XY readout, 200 APV25 electronics

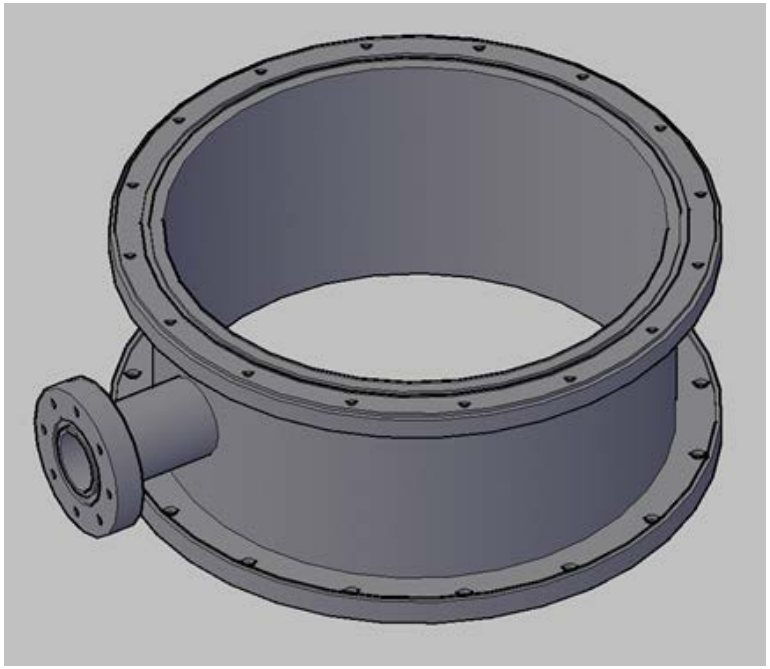


Next Step on on MicroBulk MicroMegas

New design of 20cm diameter round MicroBulk MicroMegas

Prototype: 0.5cm^2 pad, 512 APV25 electronics





总结与展望

- 已经成功利用Double Mask和Single Mask技术分别研制出30cm*30cm 和40cm*40cm GEM 膜。
- 完成了GEM探测器APV25电子学分辨和成像研究
- 用自己研发的GEM膜制成GEM探测器并进行测试。降低废品率。如果顺利的话，就可以尝试进行GEM膜小批量生产。
- 利用与GEM膜工艺非常相近的光刻蚀刻技术进行新型微网探测器研制。

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感谢核探测器与核电子学国家重点实验室开放基金支持！

Thank You !

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