



核数据重点实验室

The Progress of GEM foil at CIAE

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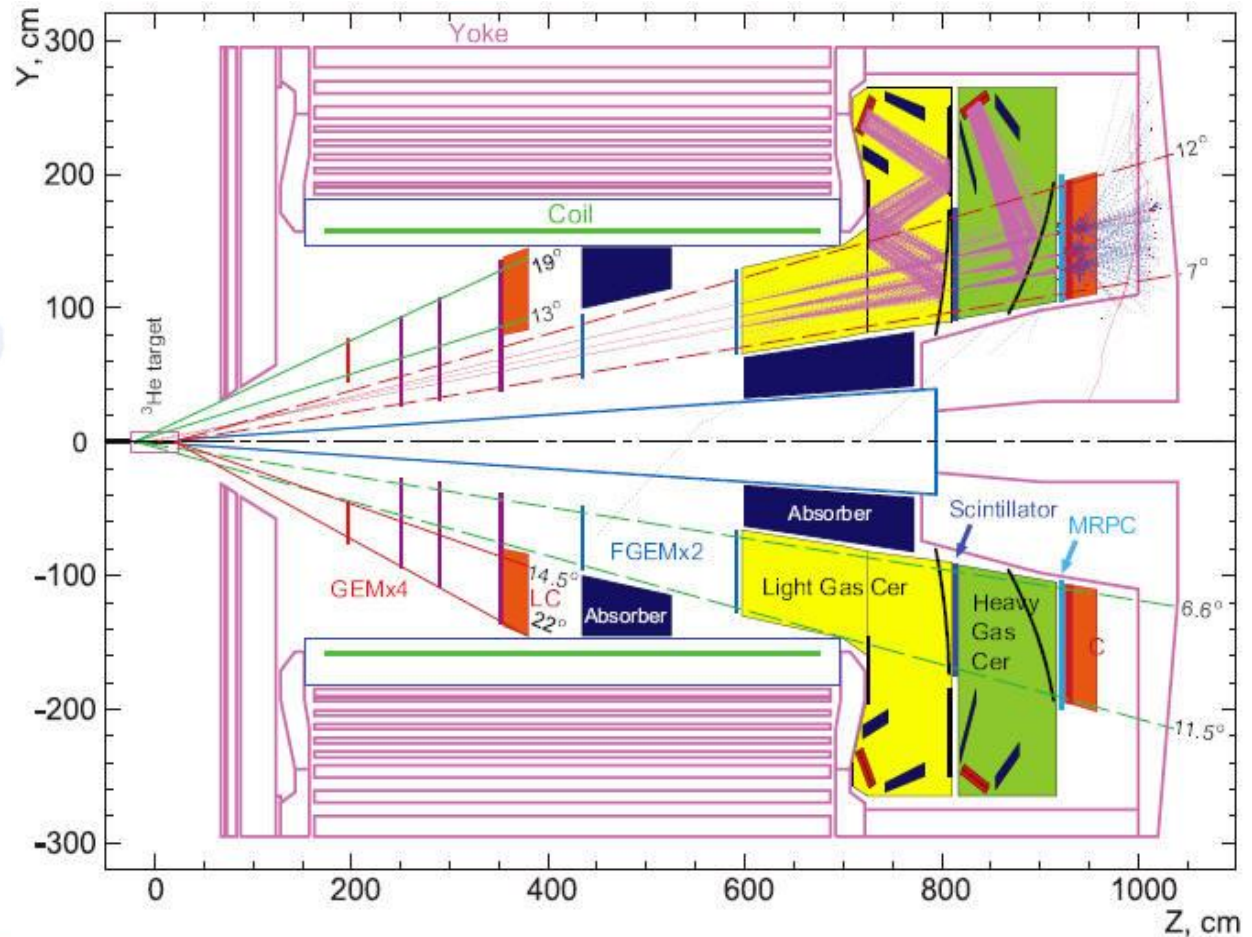
2013.07 Huangshan



SoLID spectrometer @Jlab 12 GeV

Transversity
PVDIS
Longitudinal

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Chinese SoLID Collaboration



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University of Science and Technology of China



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China Institute of Atomic Energy



清華大學
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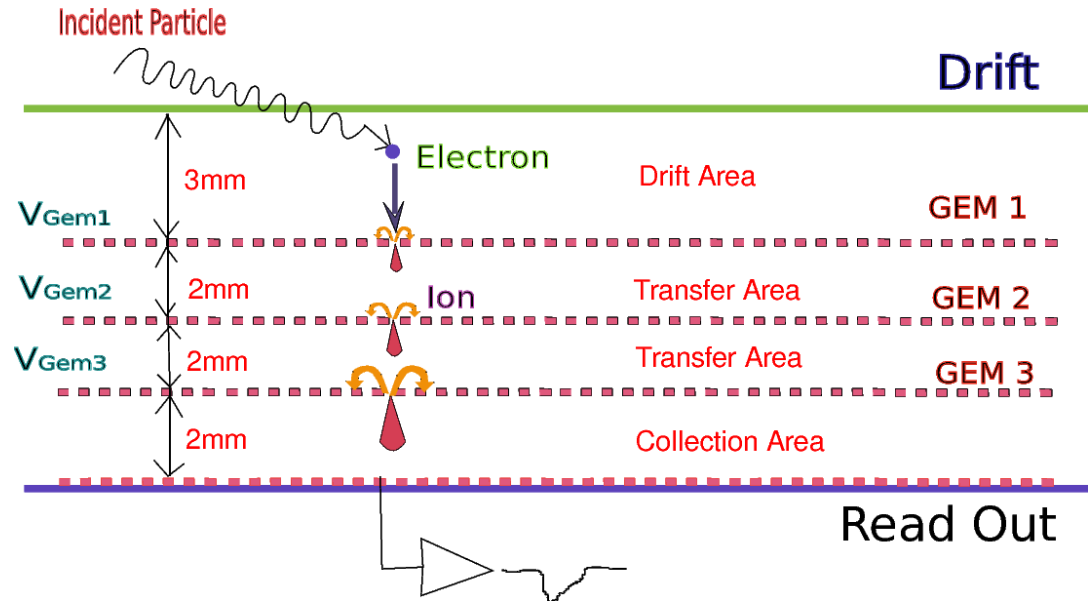


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GEM (Gas Electron Multiplier) Structure

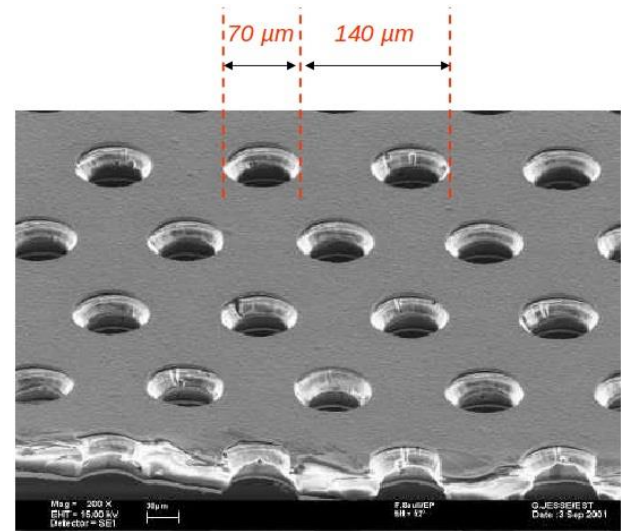
1. Core part: GEM Foil
2. Avalanche happens in the hole area only. This improves the spatial resolution in a large extent.



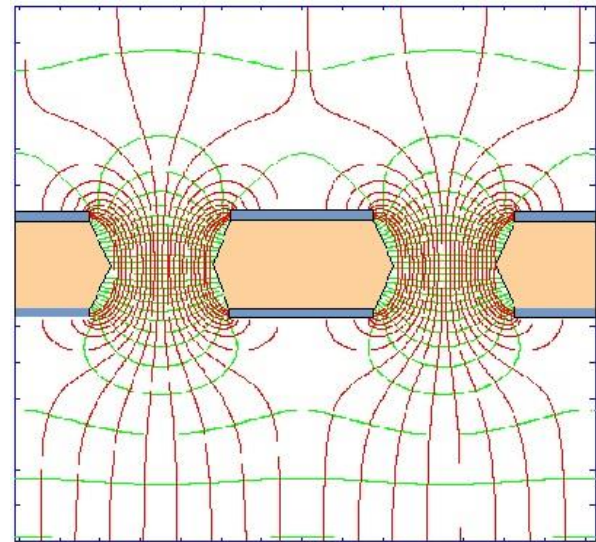
Triple-Foil GEM Detector

GEM Foil Structure

1. Typical GEM Foil has 3 layers, two $5\mu\text{m}$ thick copper foils and one $50\mu\text{m}$ thick kapton foil in the middle.
2. Diameter of the hole is $70\mu\text{m}$, and the distance between them is $140\mu\text{m}$.
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

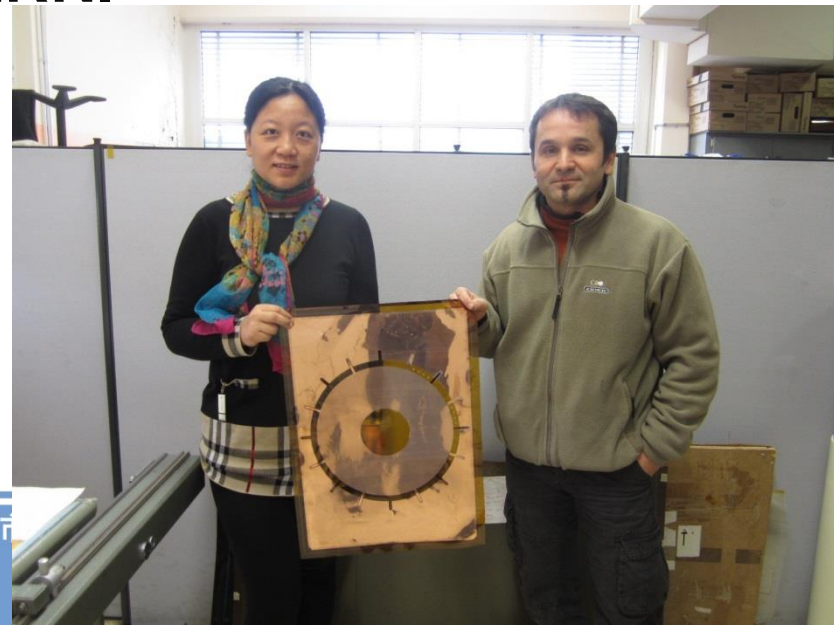


GEM Field

GEM License and Training

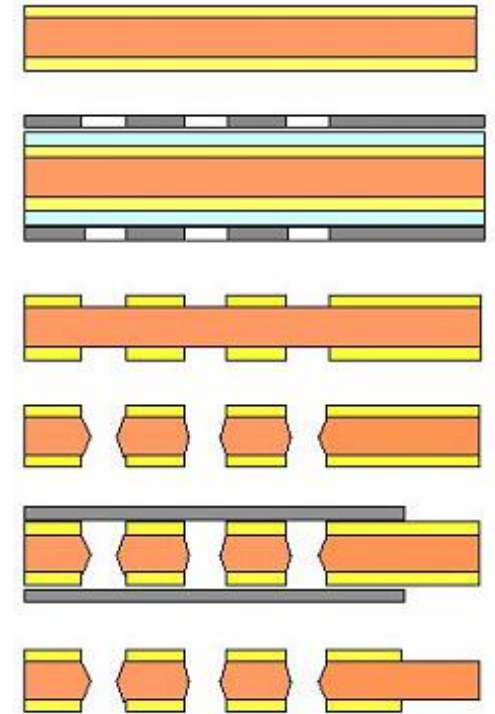
CIAE has signed officially the LICENSE AGREEMENT FOR MANUFACTURING AND COMMERCIALISATION OF GEM FOILS AND GEM-BASED PRODUCTS with CERN.

I took a training for GEM foil at CERN.



Process Flow Diagram of GEM Foil Manufacture

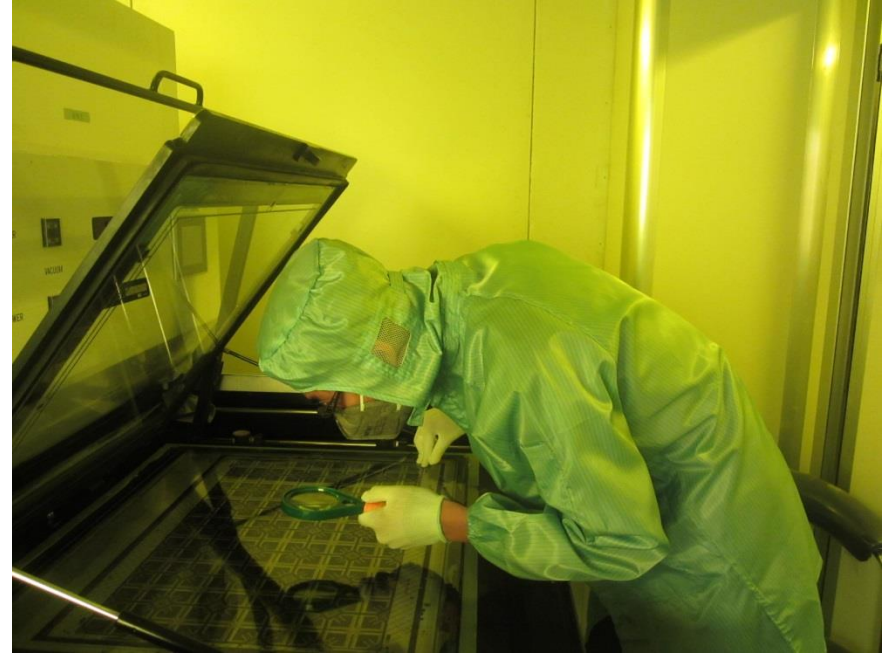
1. Raw foils
2. Preparing photo mask
3. Lamination and exposure of dry film photoresist
4. Copper etching
5. Kapton etching
6. Second masking, etching and final cleaning



**Clean room
is needed.**



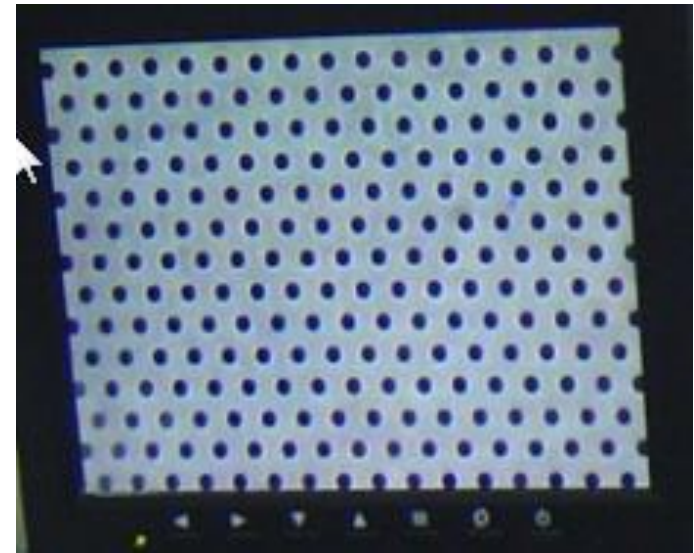
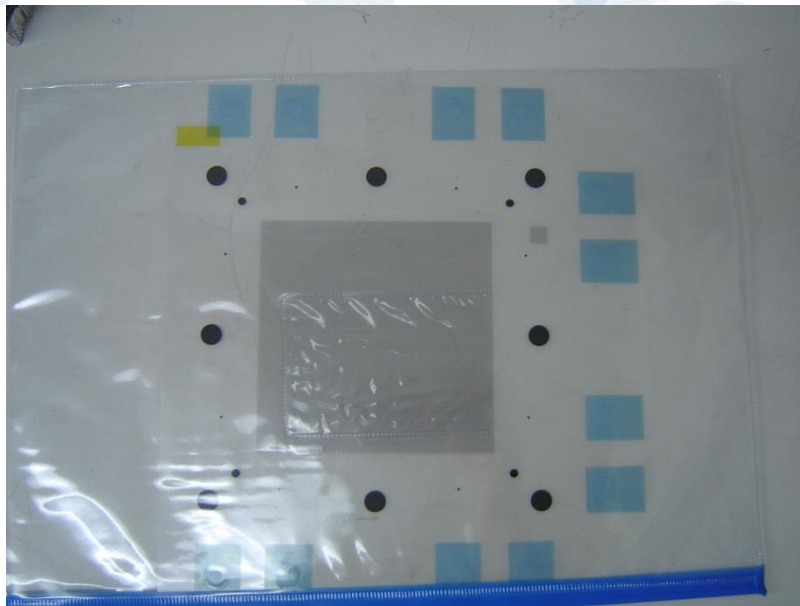
Clean Room



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



GEM Photo Mask Plate



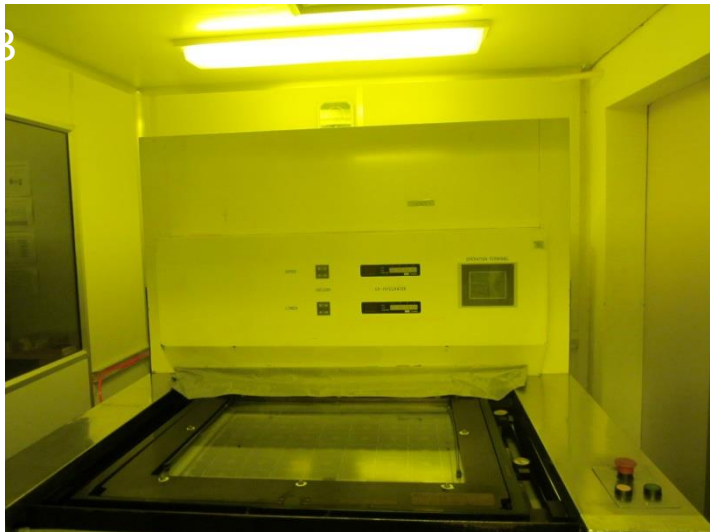
10cm*10cm mask plate



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.

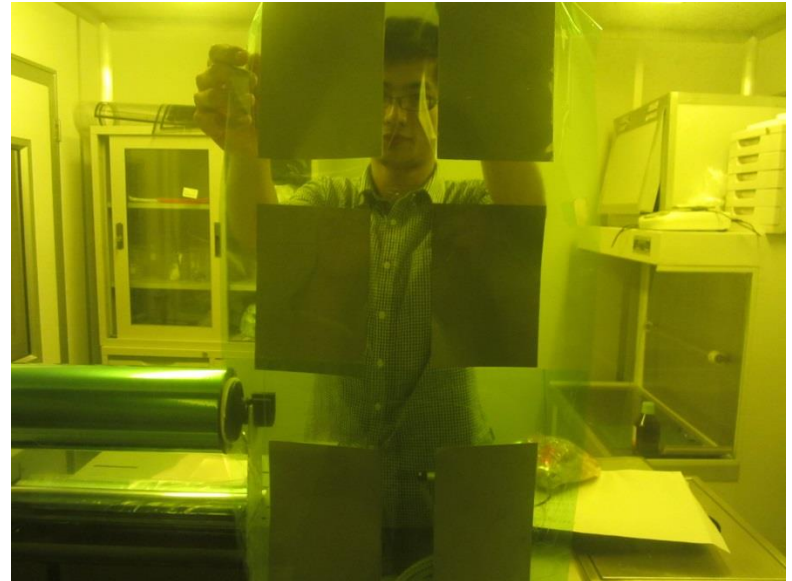
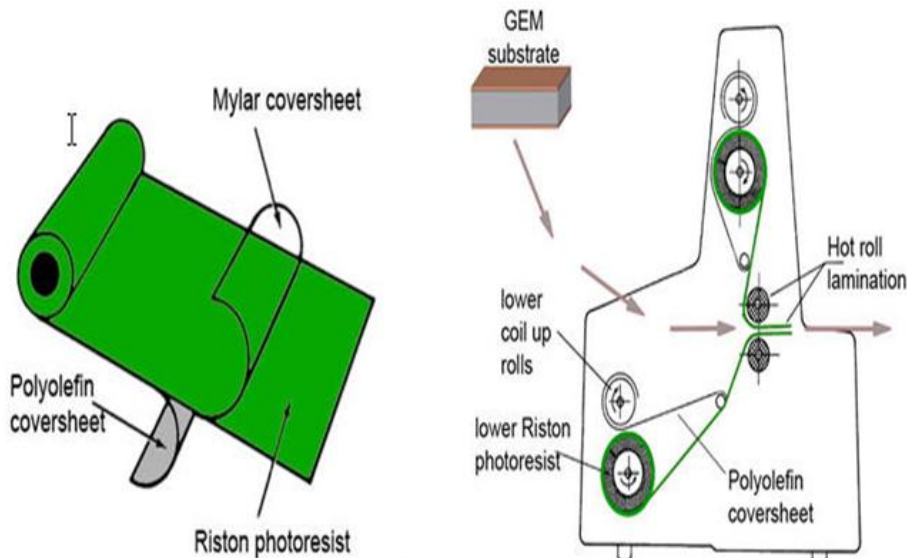


We have established a yellow light zone, and have introduced Hot Roll Lamination (HRL) machine and Exposure system.

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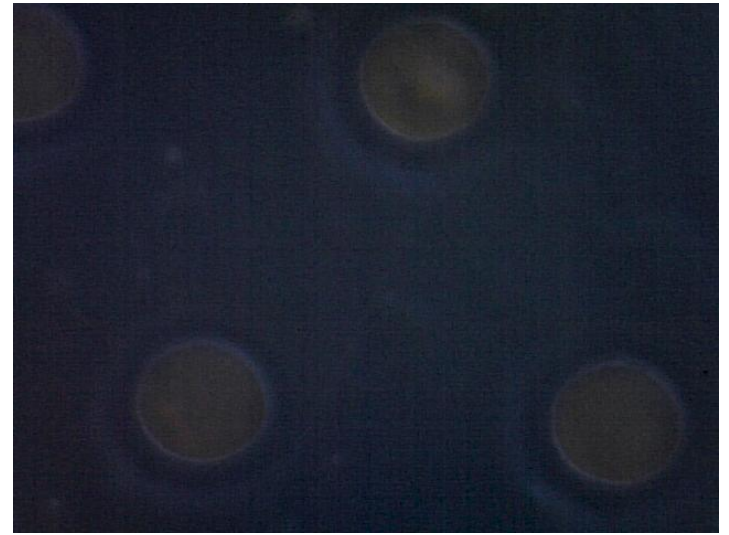
Lamination of Dry Film Photoresist

The photoresist is sandwiched between an inner polyolefin cover sheet and an outer Mylar protective layer.



Exposure of Dry Film Photoresist

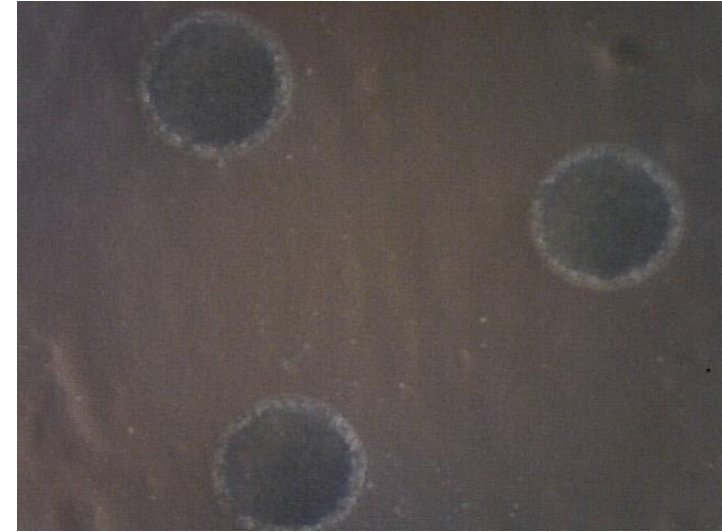
We use negative photoresist for GEM image transfer, unexposed areas are relatively unchanged and easily washed out by solvents during the development.



To obtain an identical copy of the photo-mask to the photoresist, vertical sidewalls in the resist are important.

Copper Etching

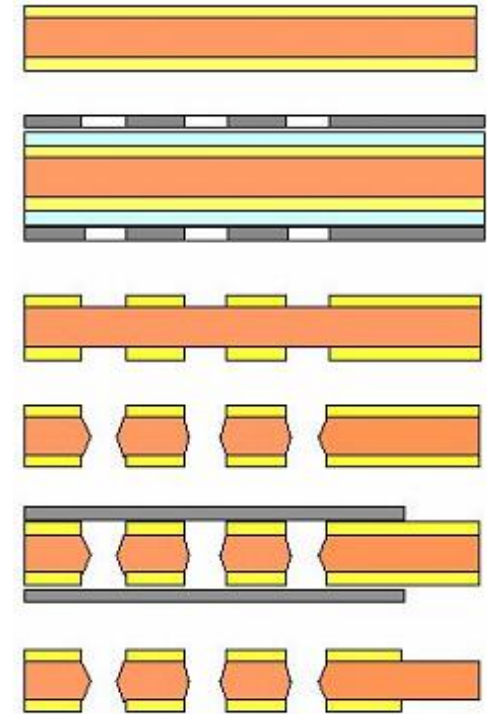
- The solution used to copper etching consists of water, ferric chloride and hydrochloric acid.
- Generally the holes in the resist of standard GEMs are 50 μm of diameter. The favored diameter of holes at copper layer is 70 μm with a pitch of 140 μm .



Remove photoresist after copper etching

Process flow diagram of GEM Foil Manufacture

1. Purchasing raw materials
2. Preparing photo mask
3. Lamination and exposure of dry film photoresist
4. Copper etching
5. Kapton etching
6. Second masking, etching and final cleaning

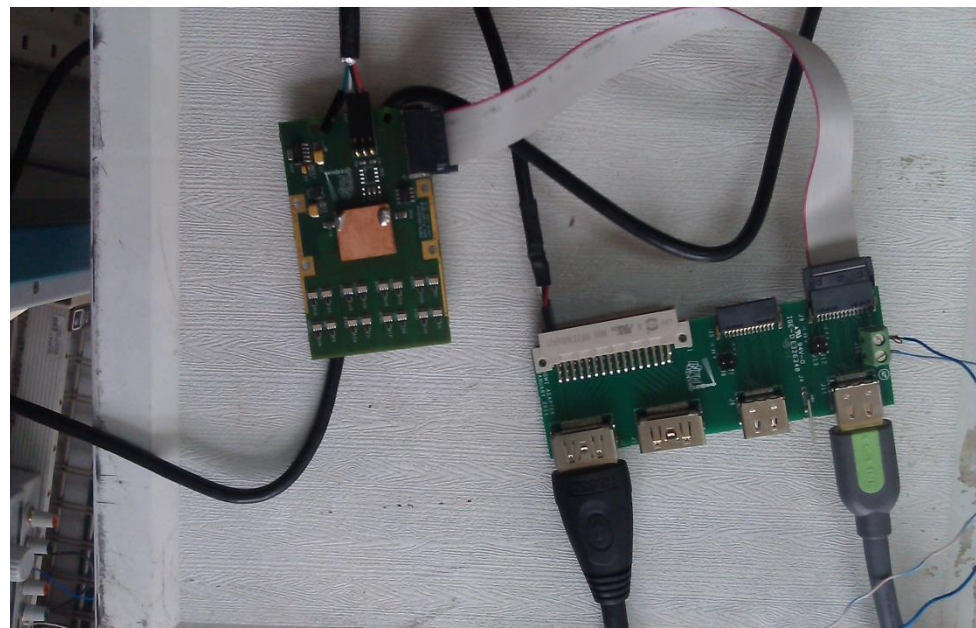


**Clean room
is needed.**



The Status of APV25 Test at CIAE

- Small APV readout system at CIAE has been installed.
- There are some problems with DAQ , and we are debugging the software
- GEM detector (10 cm x 10 cm) is ready for testing.



Small APV25 readout system
at CIAE

Next step

- 1. Do more lamination and exposure of dry film photoresist, copper etching to find the best work condition.**
- 2. Finish kapton etching in next few months**
- 3. Test APV25**
- 4. Simulation on Neutron Transfer Efficiency with Boron-GEM Foils**



**Wish to show a prototype of
30*30cm² GEM foil at the
meeting next year!**

Thank you !

