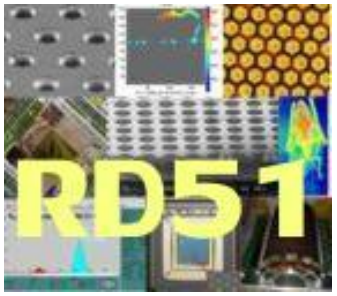
Quality Control Chamber Production

Yi Zhou

University of Science & Technology of China



Outline

The Quality control of:

- The drift electrodes
- The GEM foils
- The frames
- The readout PCBs
- The effective gas gain & gain uniformity
- The gas leakage of the Chambers

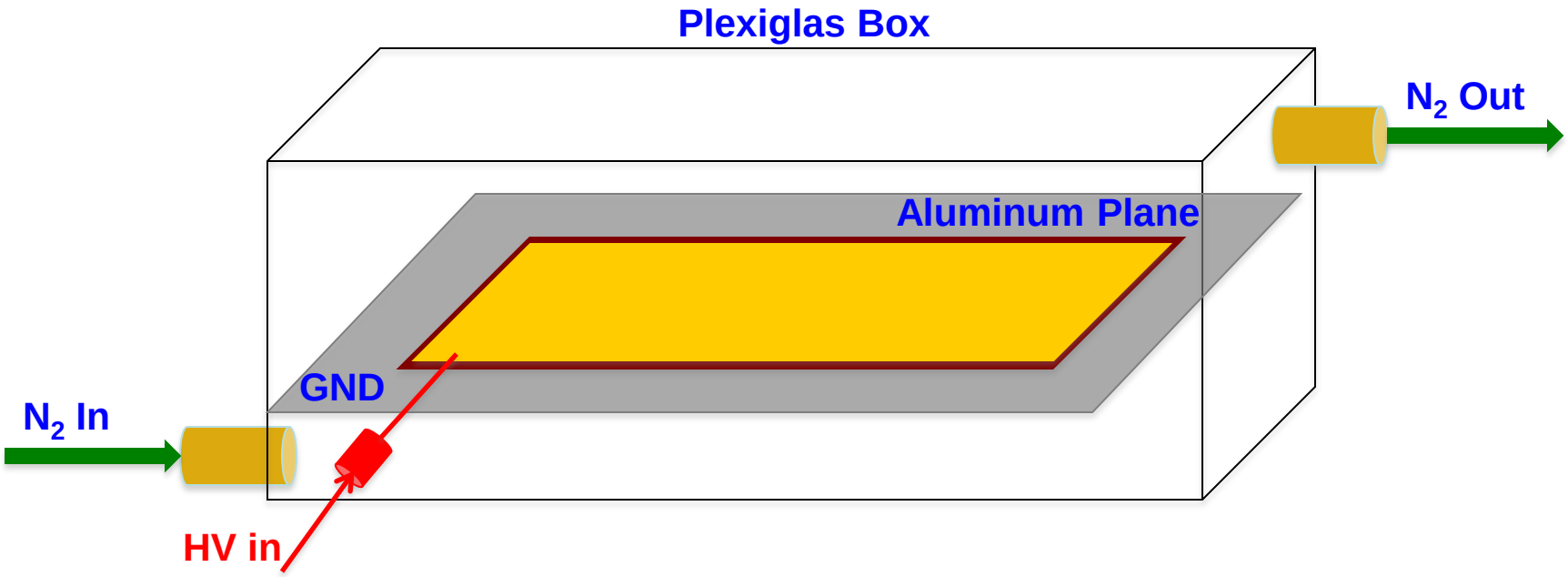
QC-Drift Electrode 1

Optical inspection

The surface of the drift electrode should be smooth, no scratch and defect on it;

No drift electrode is rejected by the optical inspection until now.(From Rui)

QC-Drift Electrode 2

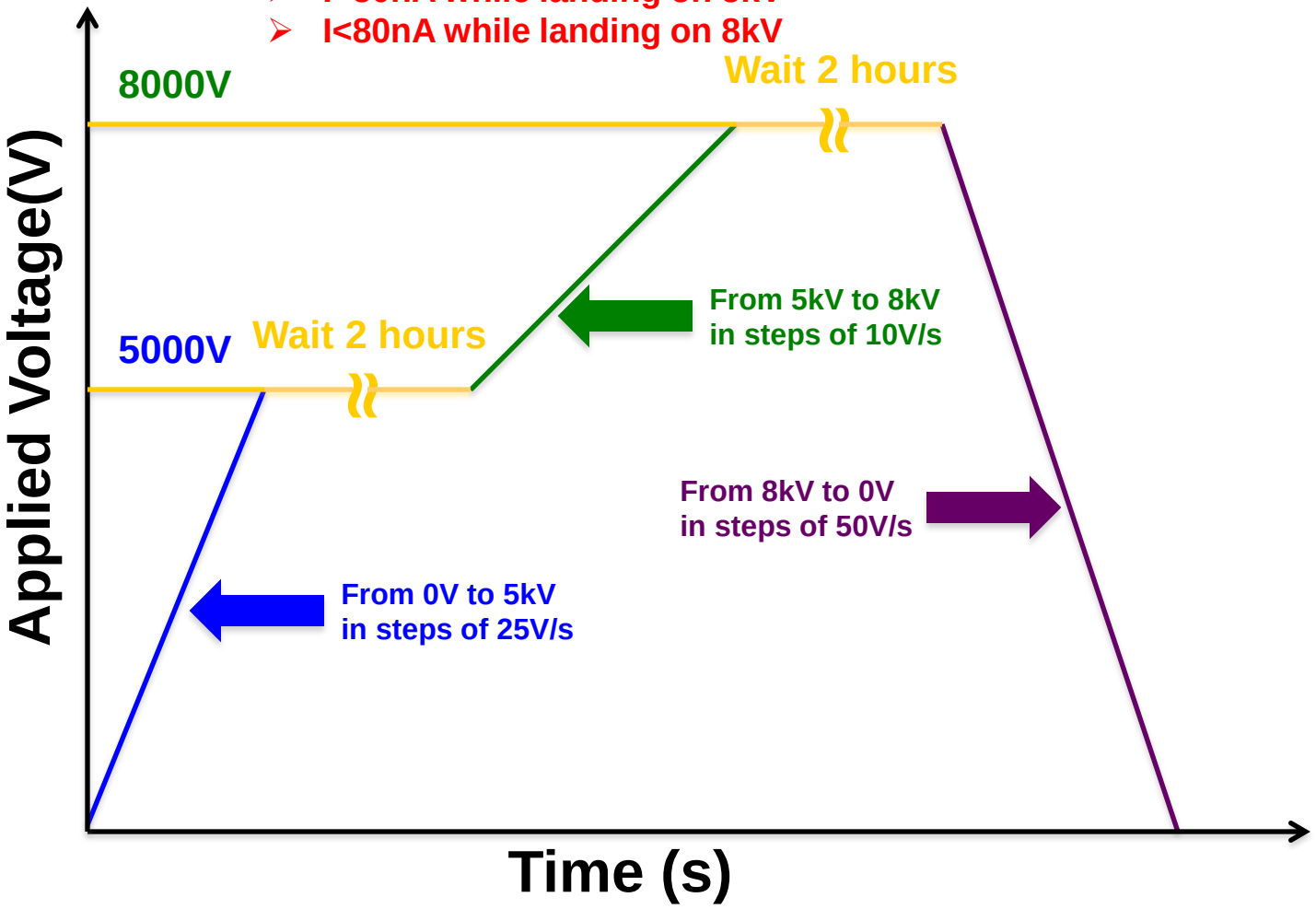


- *Use the nitrogen gun to clean the electrode gently;*
- *Put the electrode on the aluminum ground plane(the kapton side towards the aluminum plane), connect the electrode to the HV power supply;*
- *close the Plexiglas box and flush the dry nitrogen(>15 liter/hour) for 2~3 hours ;*

QC-Drift Electrode 3

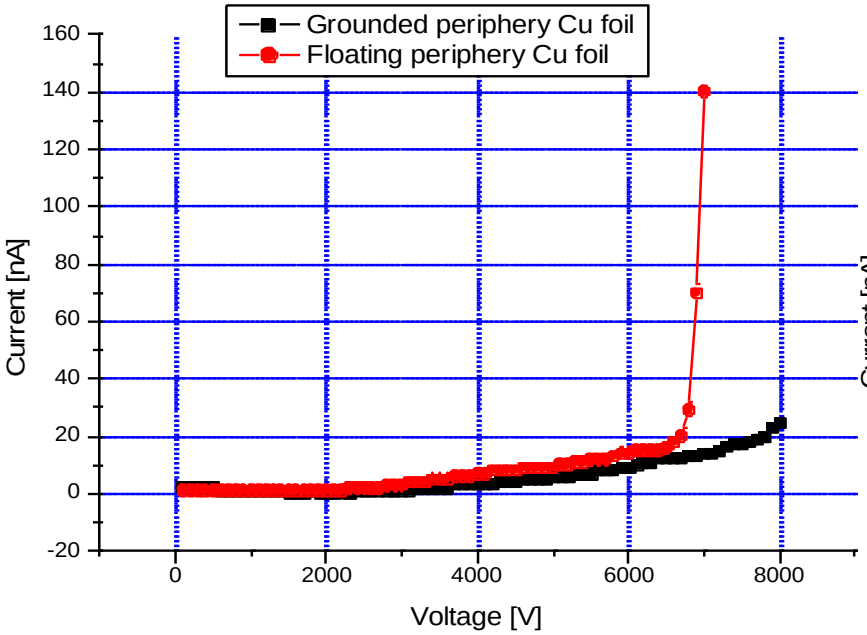
Validation:

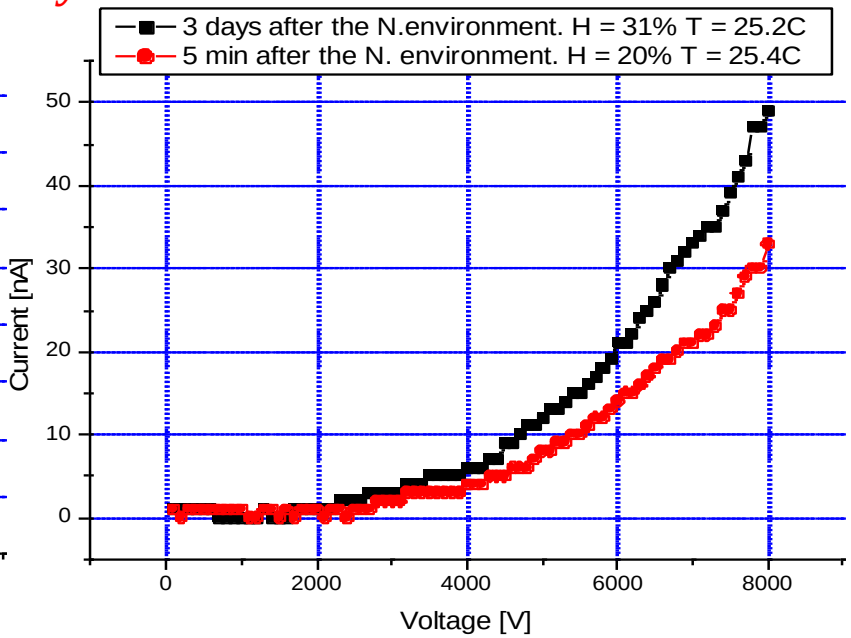
- **I<50nA while landing on 5kV**
- **I<80nA while landing on 8kV**

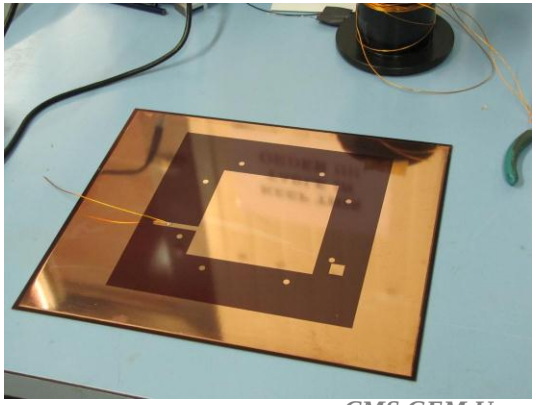


Old Test Results

From Andrey





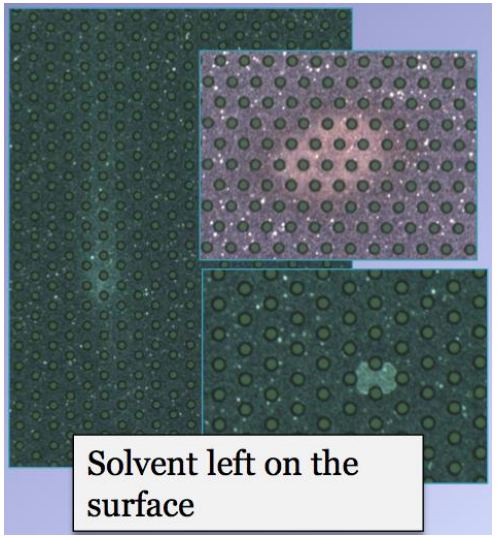


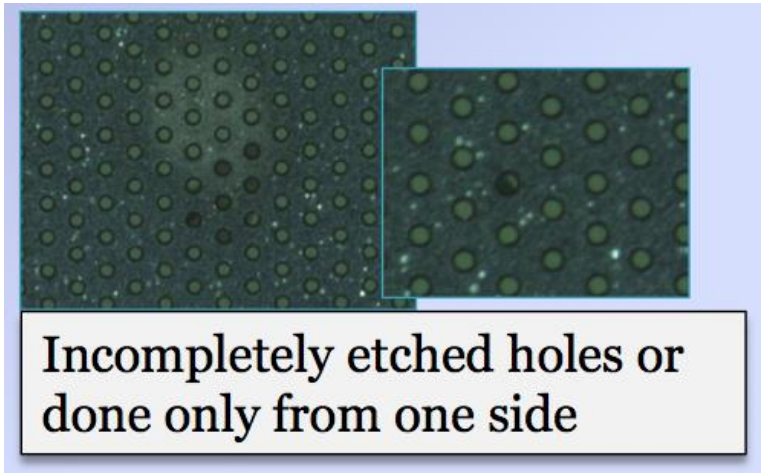
QC-GEM foils 1

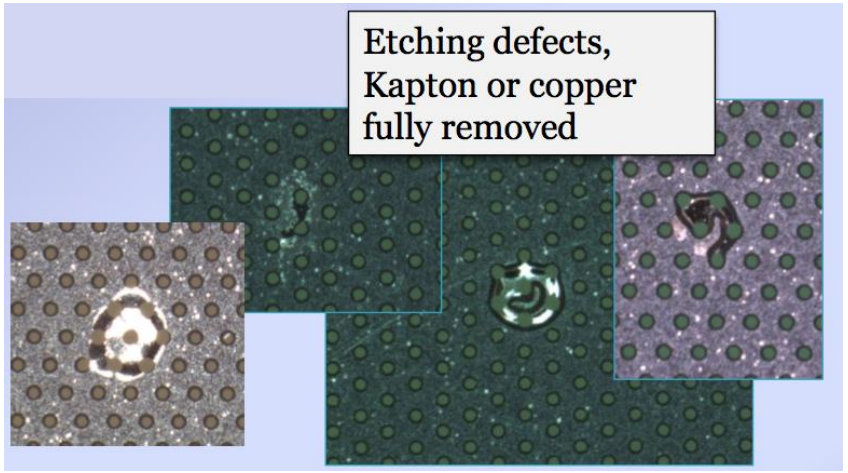
Optical inspection

- *No scratch, etching defect and incompletely etched holes;*
- *The maximum misalignment between kapton and copper should be less than 10μm;*
- *Make sure no holes are cut at the edge of each sector.*

10% of the large area GEM foils are rejected by the optical inspection .(From Rui)

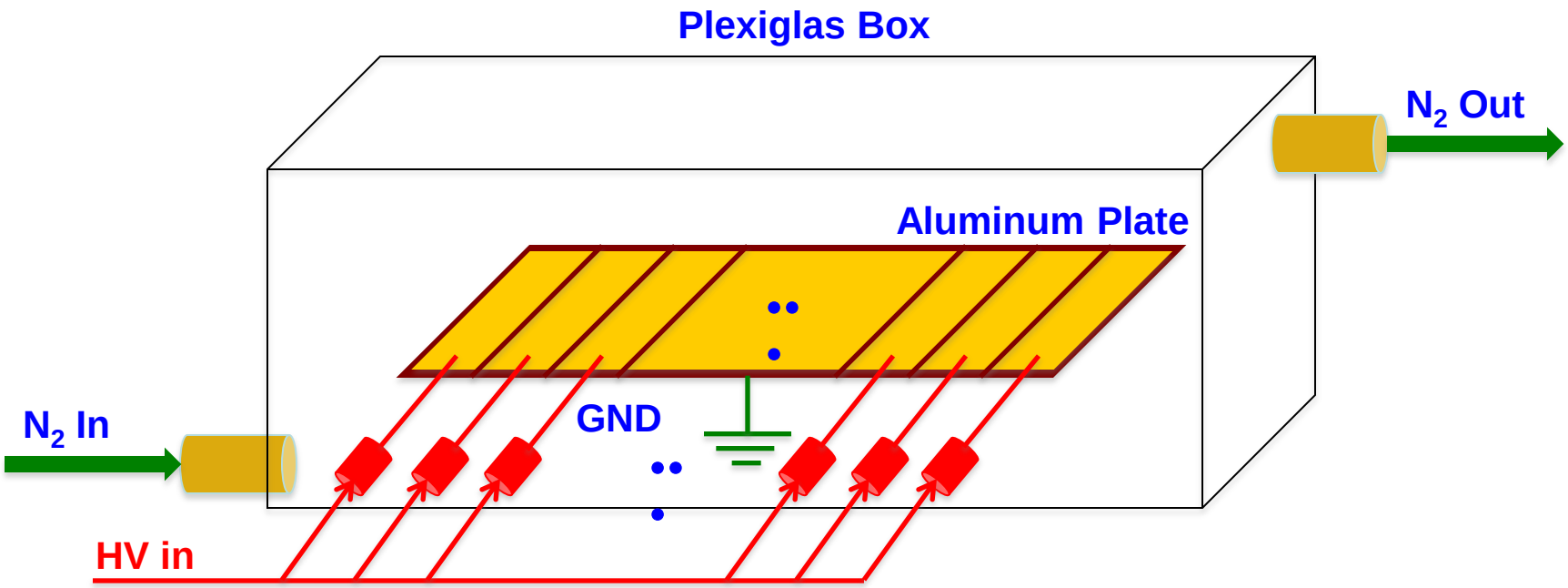






QC-GEM foils 2

Preparation for the HV Test

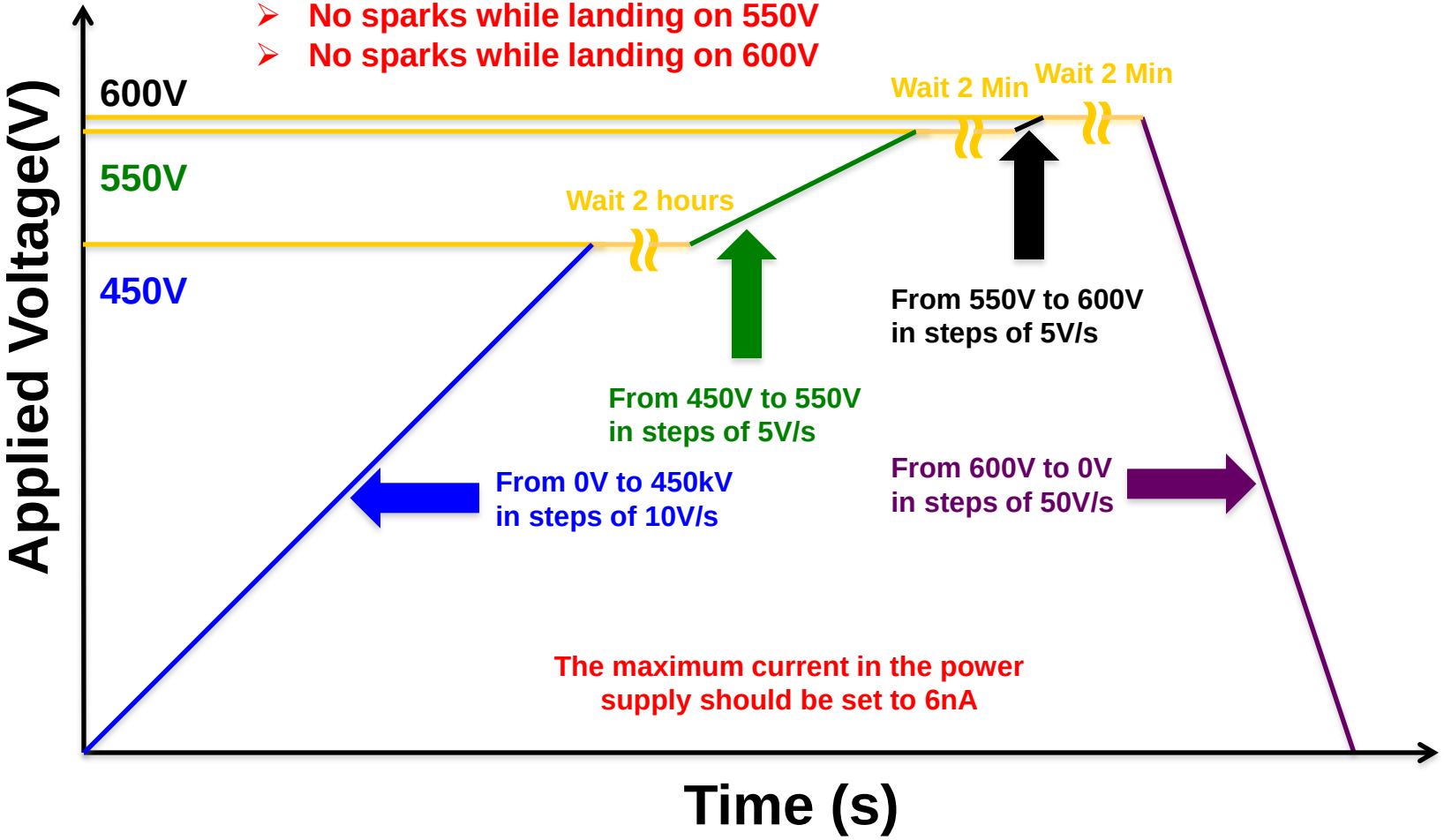


- *Use the nitrogen gun to clean the GEM foil gently;*
- *Put the GEM foil in the Plexiglas Box, connect the non-sectored side to the ground, connect each sector to the corresponding channel of the HV power supply;*
- *close the Plexiglas box and flush the dry nitrogen(>15 liter/hour) for 2~3 hours ;*

QC-GEM foils 3

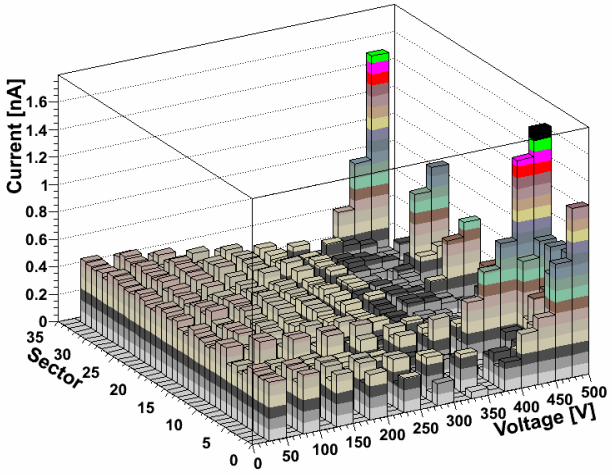
Validation:

- I<4.5nA while landing on 450V
- No sparks while landing on 550V
- No sparks while landing on 600V

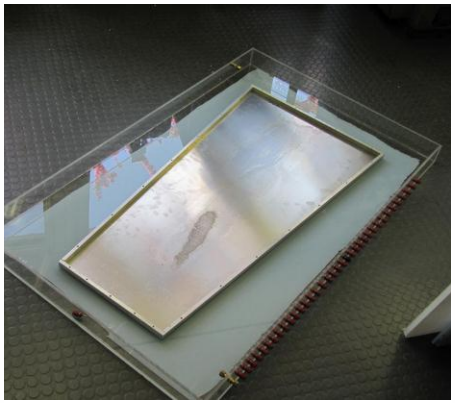


Old Test Results

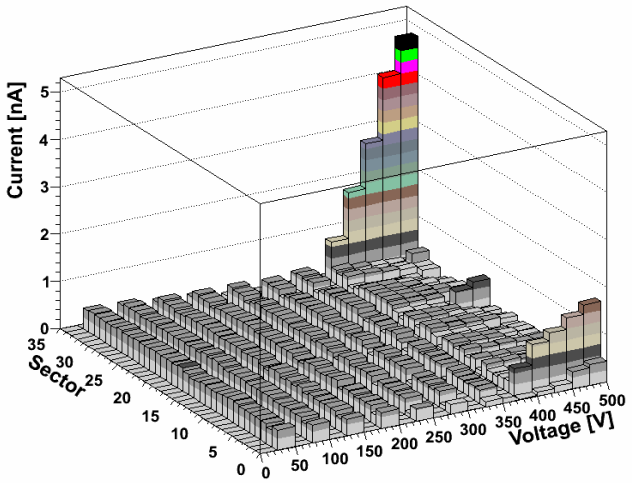
GEM3_Foil



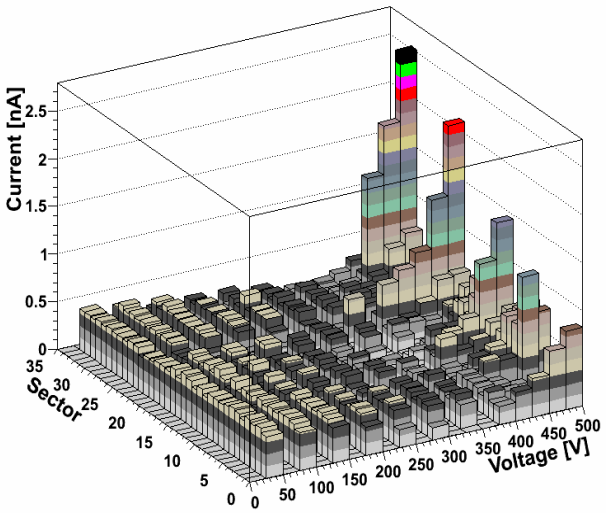
From Andrey

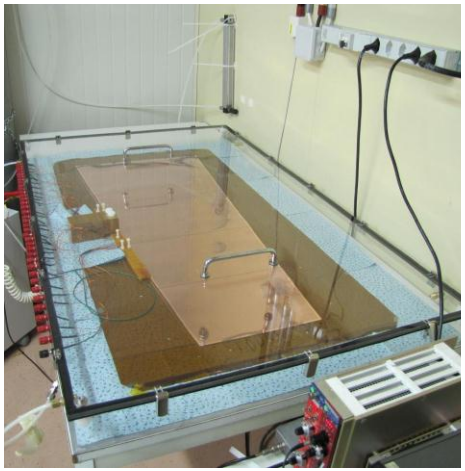


GEM3_Stretched

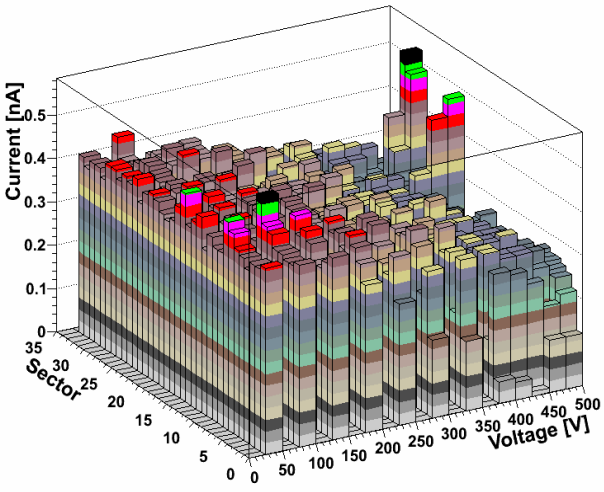


GEM6_Foil





GEM6_Stretched

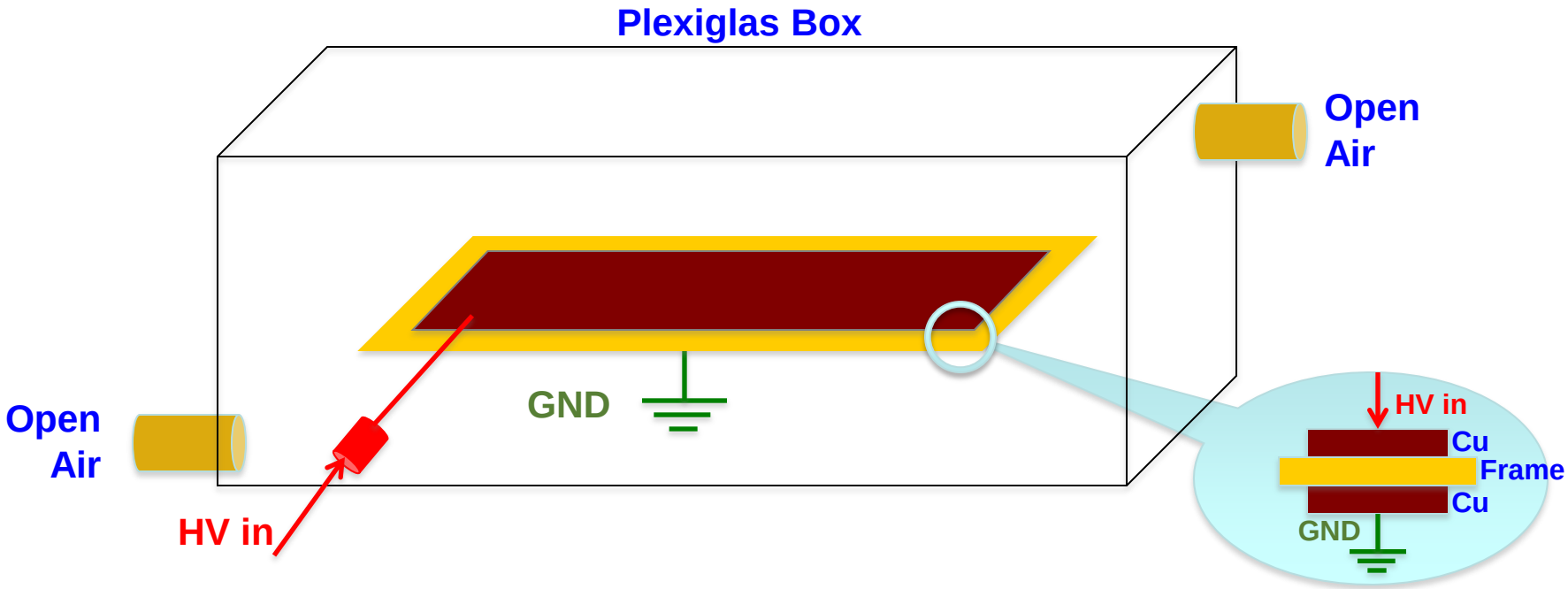


QC-Frames 1

- The internal edge of the frame is preliminary sanded (outside the clean room);
- The part of the frame in contact with the active area of the detector should be sprayed with the Polyurethane to avoid the spikes and fibers; (This step can be ignored if the manufacture of the frames is perfect)
- Introduce the frame in a cleaning-box and fill the box with demineralized water, then place the cleaning-box in the ultrasonic bath for 4 minutes;
- The frames are dried in a oven at 40° C for about 4 hours, then stored the frames in a clean cabinet.

QC-Frames 2

Preparation for the HV Test



- *Put the frame between two copper planes, the top copper connects to the HV power supply, the bottom copper connects to the ground;*
- *This test should be done in the open air;*

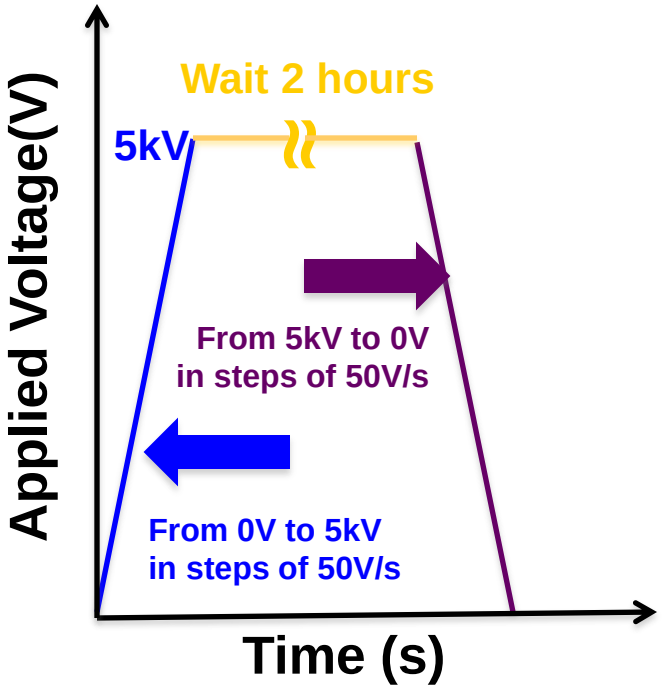
QC-Frames 3

Validation:

- **Hold 5kV in open air without sparks**

If there are sparks occur:

- **Ramping down the HV, left the frame in the Plexiglas box for 2 hours;**
- **Test is again, if no sparks, it is ok;**
- **If there are still sparks, clean it again.**

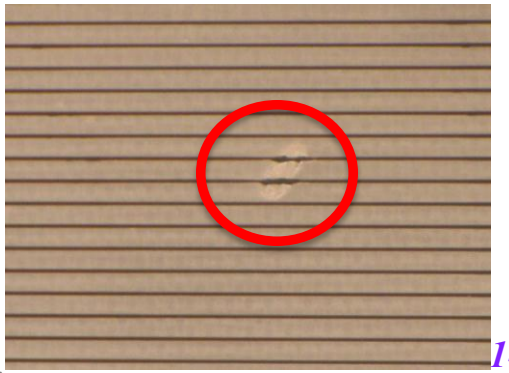


QC-Readout PCB

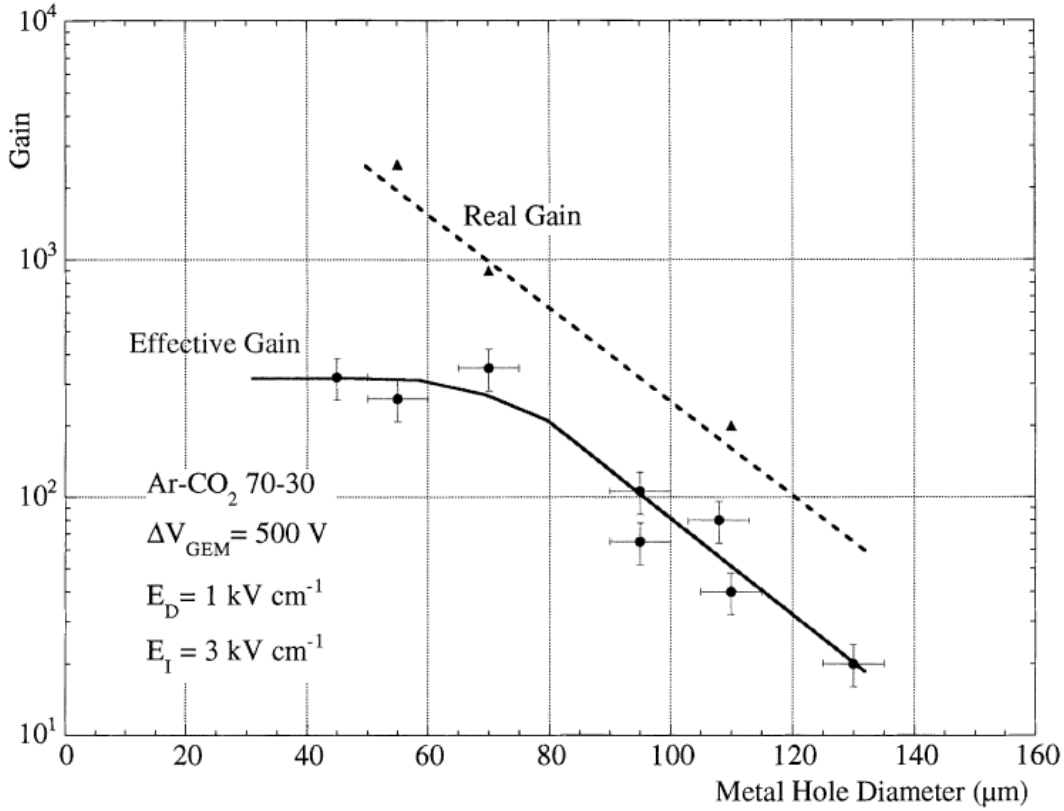
- **The PCB factory guaranteed that the mechanical tolerance of the PCB is about 50ppm by using the Glass mask technology .(From Rui)**

- **All the electronic connections should be correct.**

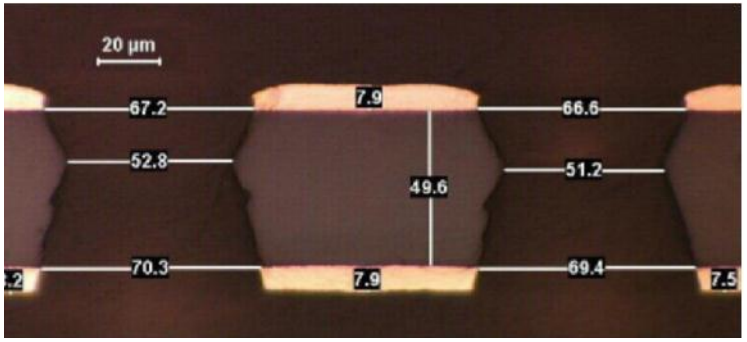
- **The surface of the readout strips smooth and no scratch & defect.**



Effective gain .VS. Hole diameters

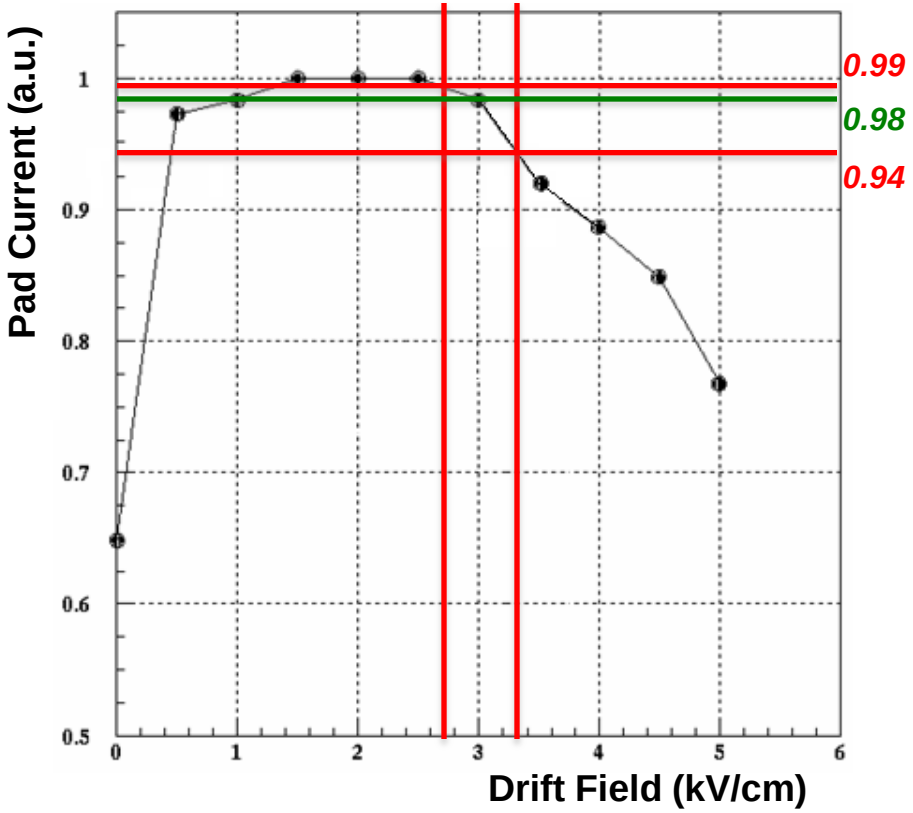


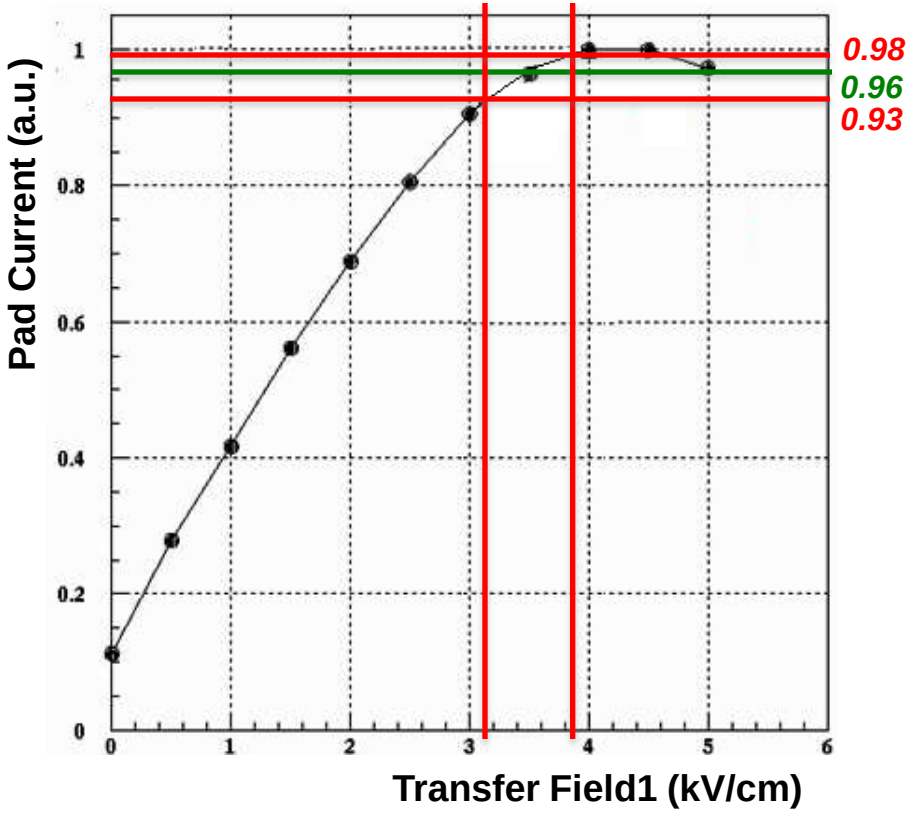
The effective gain saturates for the hole diameter from 50μm to 70μm, so that we can ignore the effect from the tolerance of the hole diameter .



Mechanical tolerance of frame 1 & 2

The Mechanical tolerance of all frames & spacers is ±10%



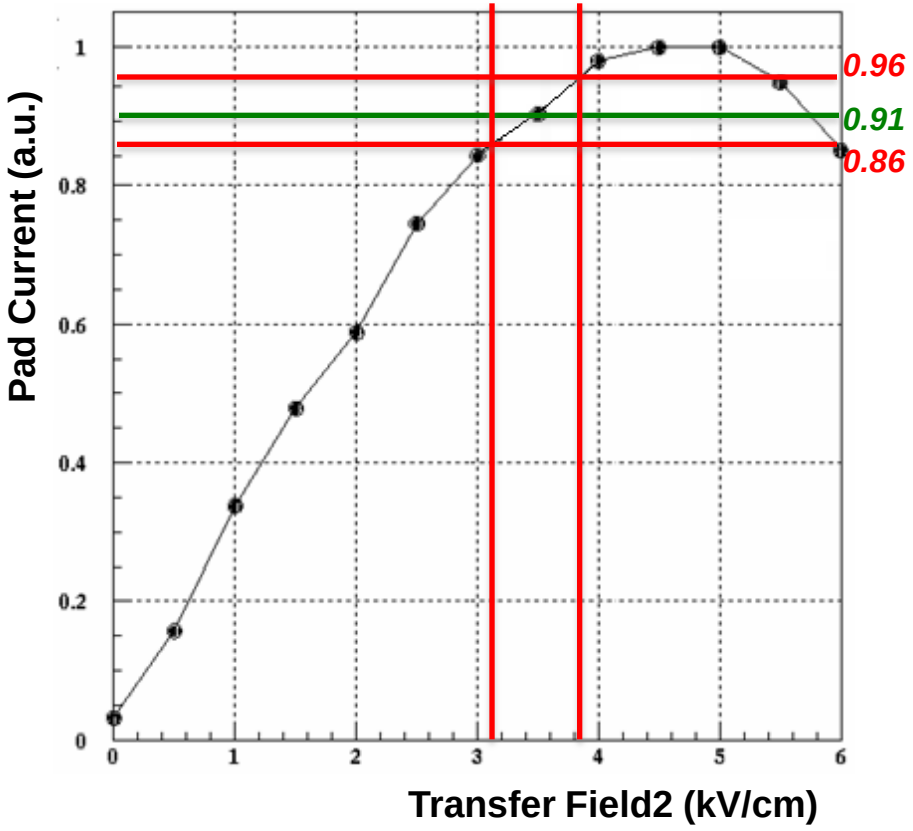


±10% δGap=>±10%δE_D=> 4%δGain

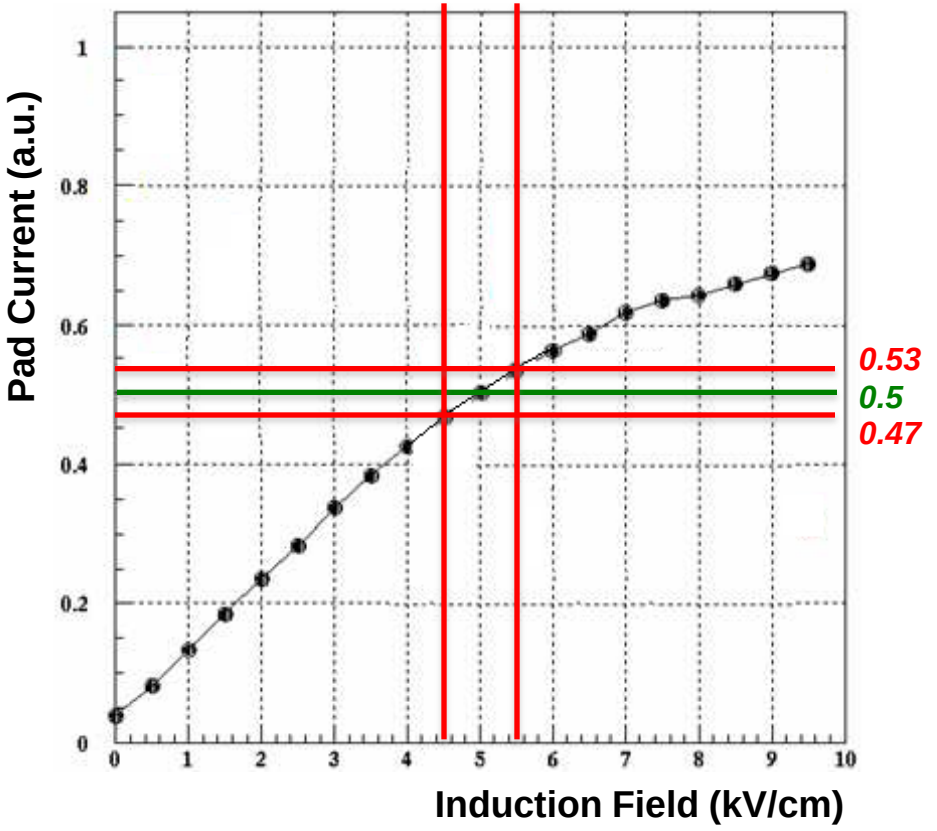
±10% δGap=>±10%δE_D=> 3%δGain

Mechanical tolerance of frame 3 & 4

The Mechanical tolerance of all frames & spacers is ±10%



±10% δGap=>±10%δE_{T2}=> 5%δGain



±10% δGap=>±10%δE_{T1}=> 4%δGain

ΔG_{eff} from *mechanical tolerance estimate*

Total ΔG_{eff} is :

$$d = \sqrt{(4\%)^2 + (3\%)^2 + (5\%)^2 + (4\%)^2} \approx 8.12\%$$

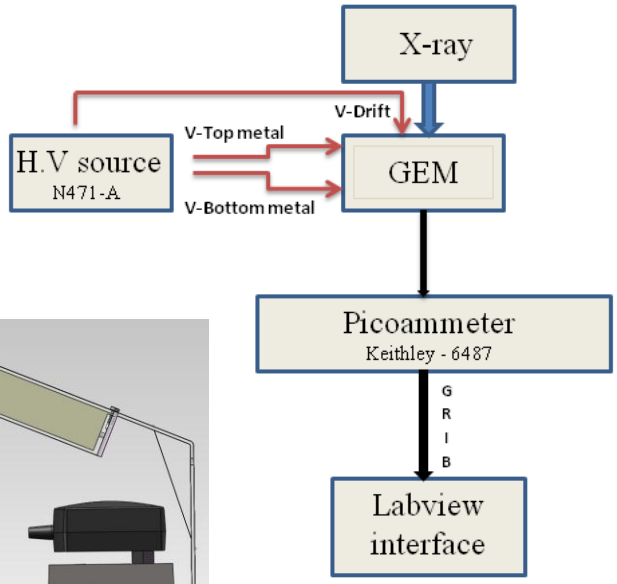
Gain uniformity test

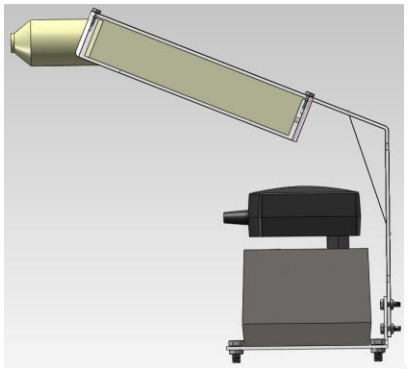
Keep temperature & humidity constant

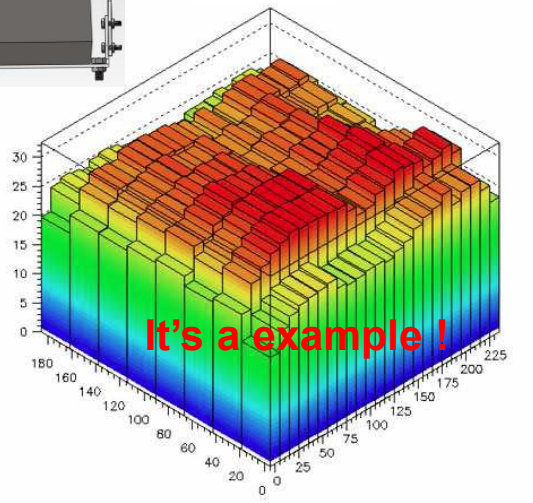
Or

Use a sensor to monitor the temperature and humidity.

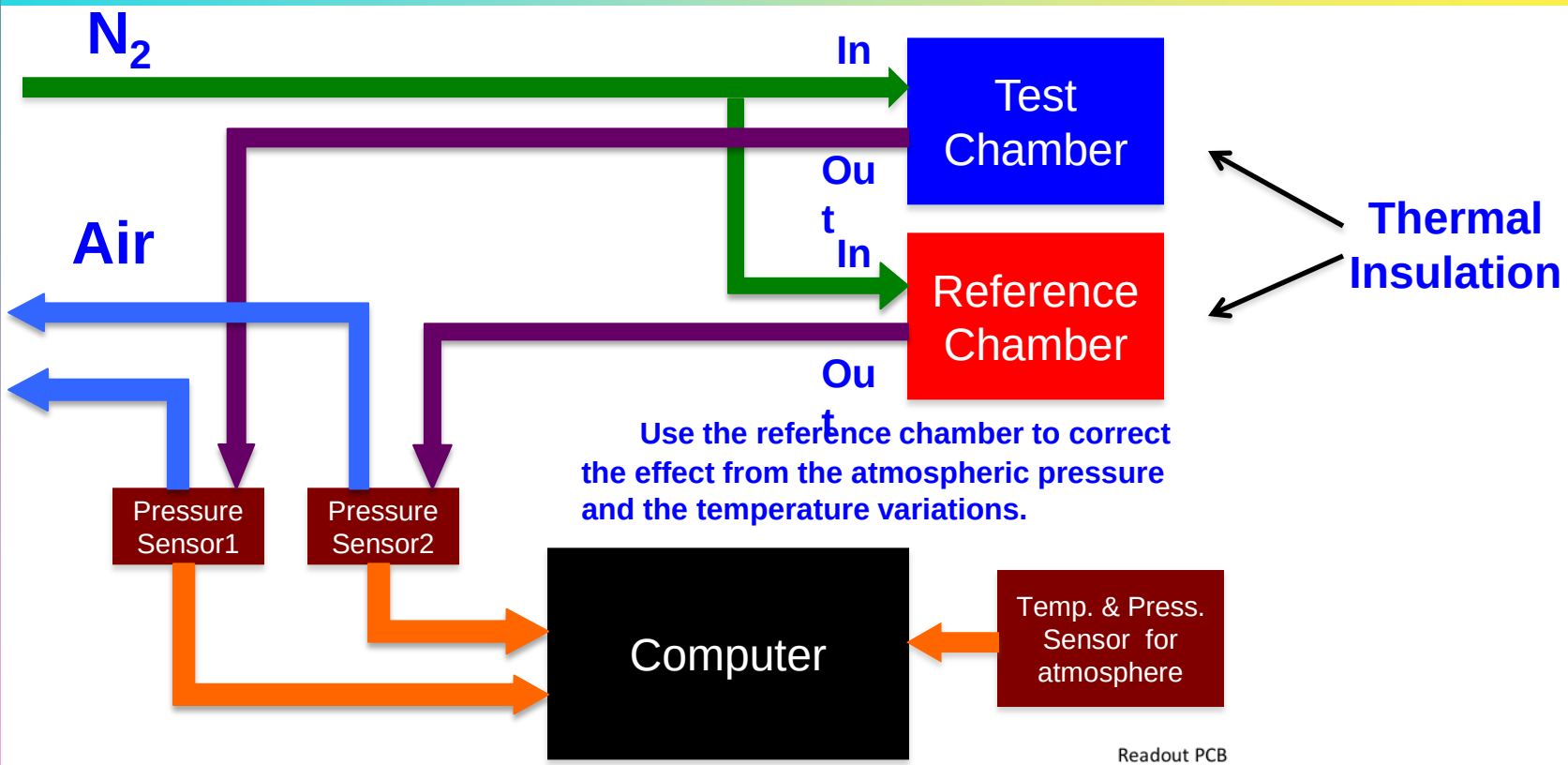
- ***Use the computer controlled step-motor to move the X-ray gun(or GEM);***
- ***Use the convert-PCB to connect the readout strips in an area(need calculate) together;***
- ***The gas gain should be performed by irradiating the triple-GEM prototype with the high intensity 8 keV X-ray tube.***
  The current induced on the readout strips I, for a given X-ray flux Φ and irradiating area S, is proportional to the detector gain G, through the relation: $I = e \cdot N_\gamma \cdot S \cdot \Phi \cdot G$ where e is the electron charge and N_γ is the gas ionization produced by the X-ray).

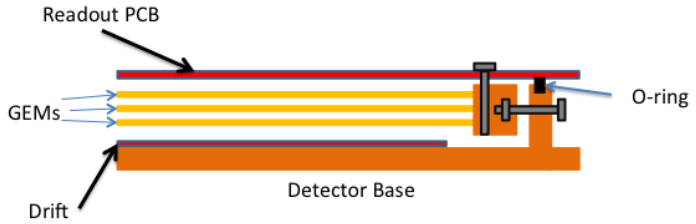






Gas leak check





A gas tight detector should have a leak rate less than 20mbar/day.


Thank You