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First Result of Charging-up "Free" THGEM Detectors

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Outline

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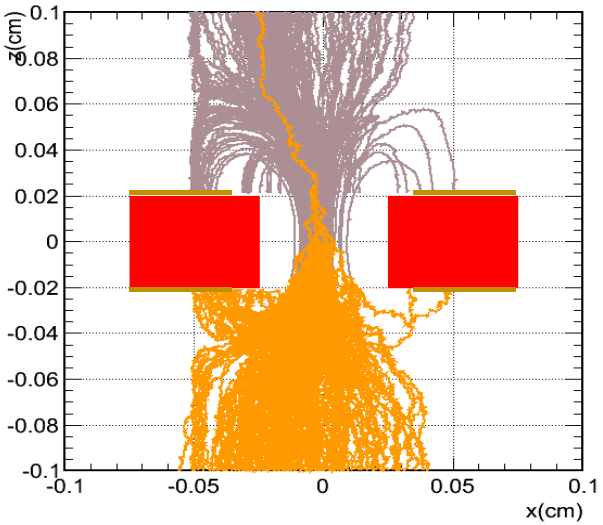
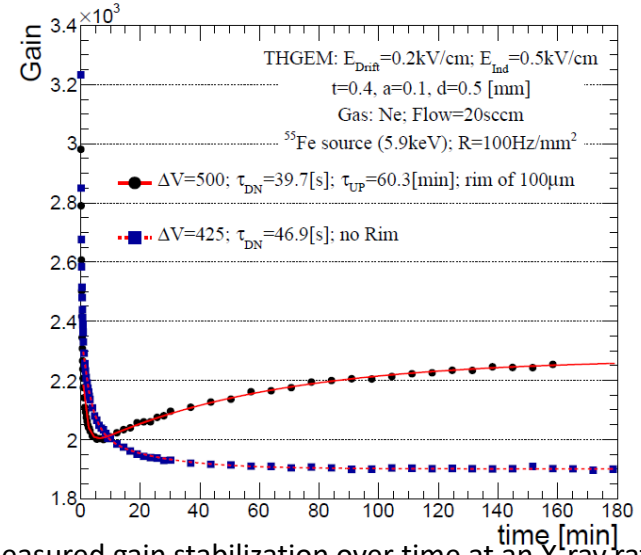
2. Experimental setup
3. Preliminary results
   - 3.1 Basic properties
   - 3.2 Evolution of gain
   - 3.3 Gain .VS. rate
4. Summary and Future work

Motivation

- Gas detectors with open insulator surfaces exhibit gain evolution versus time (charging-up effect). The evolution has been observed in LST, MSGC, GEM, THGEM….

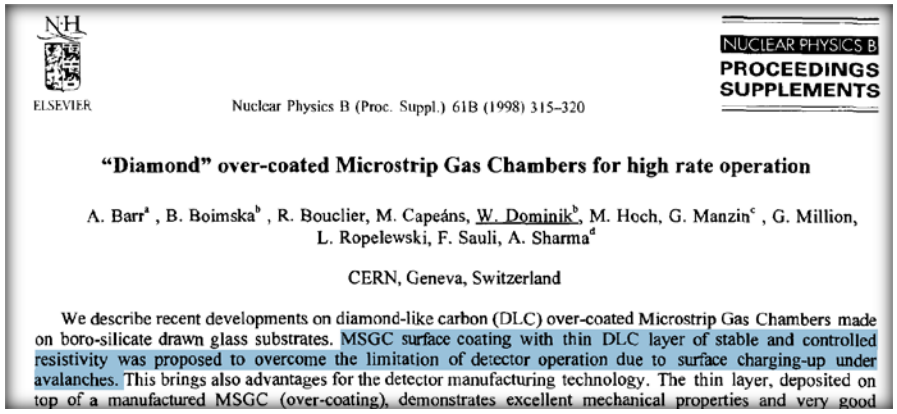


(a)Simulated electron avalanche in THGEM hole



(b)Measured gain stabilization over time at an X-ray rate of 100 Hz/mm^2, for an electrode with hole-rim (black) and without rim (blue)

- MSGC surface coating with DLC (Diamond-Like Carbon) was employed to overcome surface Charging-up and achieved good results in 1998.
- Coating DLC on THGEM dielectric surface may help to solve THGEM charging-up problem.



ELSEVIER

Nuclear Physics B (Proc. Suppl.) 61B (1998) 315–320

NUCLEAR PHYSICS B
PROCEEDINGS
SUPPLEMENTS

"Diamond" over-coated Microstrip Gas Chambers for high rate operation

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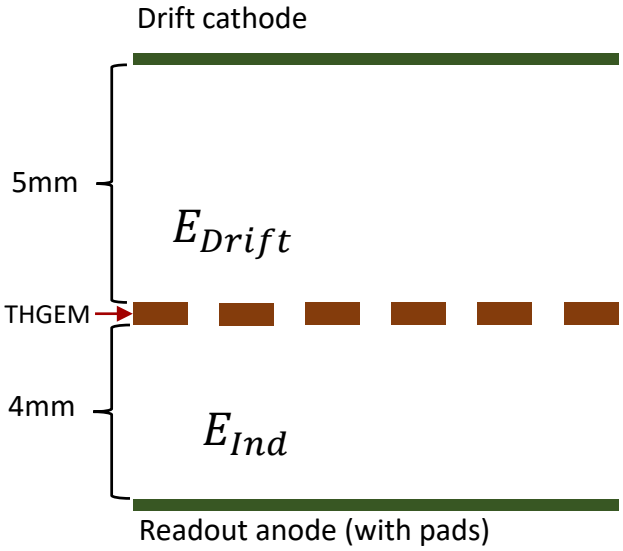
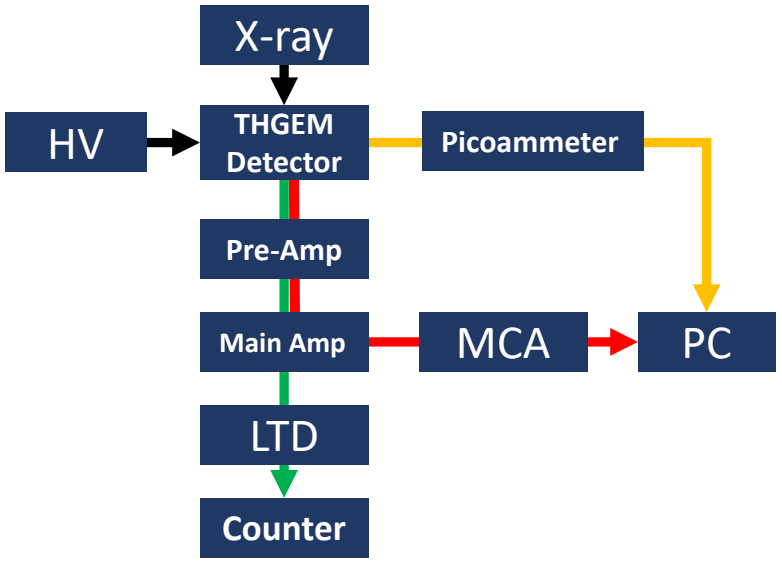
We describe recent developments on diamond-like carbon (DLC) over-coated Microstrip Gas Chambers made on boro-silicate drawn glass substrates. MSGC surface coating with thin DLC layer of stable and controlled resistivity was proposed to overcome the limitation of detector operation due to surface charging-up under avalanches. This brings also advantages for the detector manufacturing technology. The thin layer, deposited on top of a manufactured MSGC (over-coating), demonstrates excellent mechanical properties and very good

Experimental setup

- Single-layer THGEM detectors were fabricated and tested.
- We measured anode current with pico-ammeter, irradiation rate with LTD and counter, charge spectrum with MCA.
- 95%Ar+5%Isobutane gas mixture.



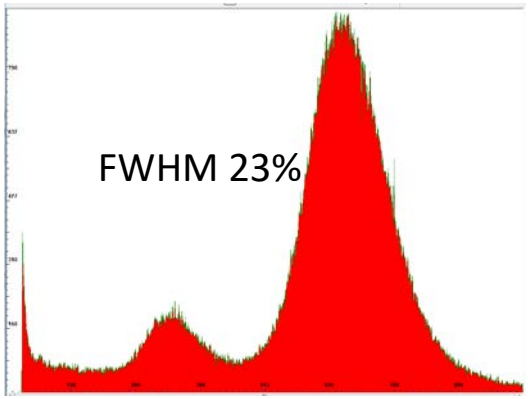
(a) Cross section of the THGEM chamber



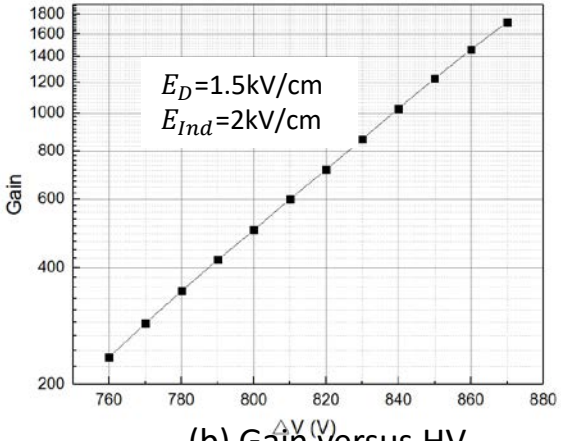
(b)Experiment flow diagram

Preliminary Results

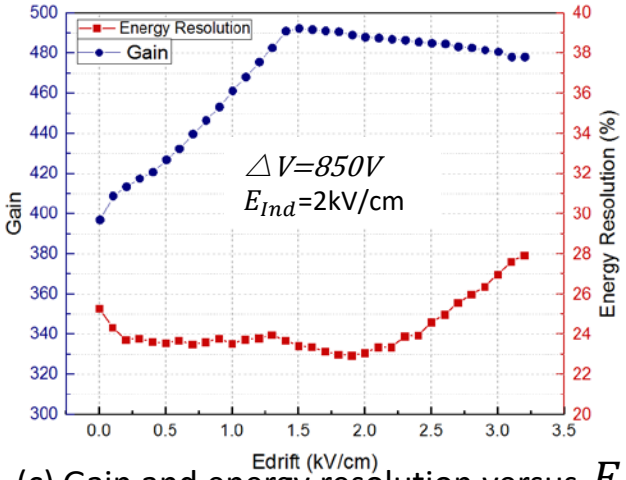
- 200GΩ DLC-THGEM basic properties



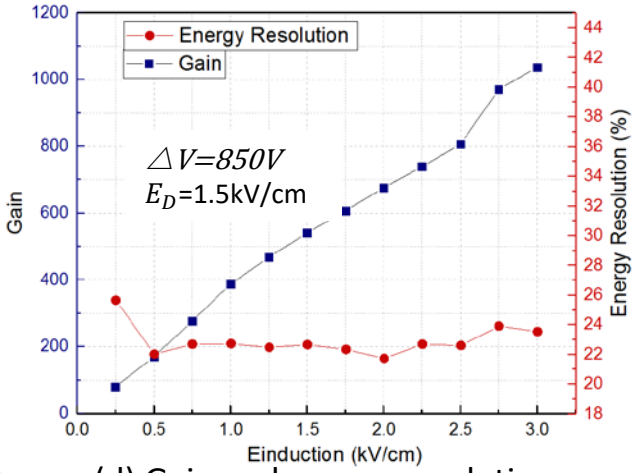
(a) Fe55 5.9keV X-ray spectrum



(b) Gain versus HV



(c) Gain and energy resolution versus E_{drift}

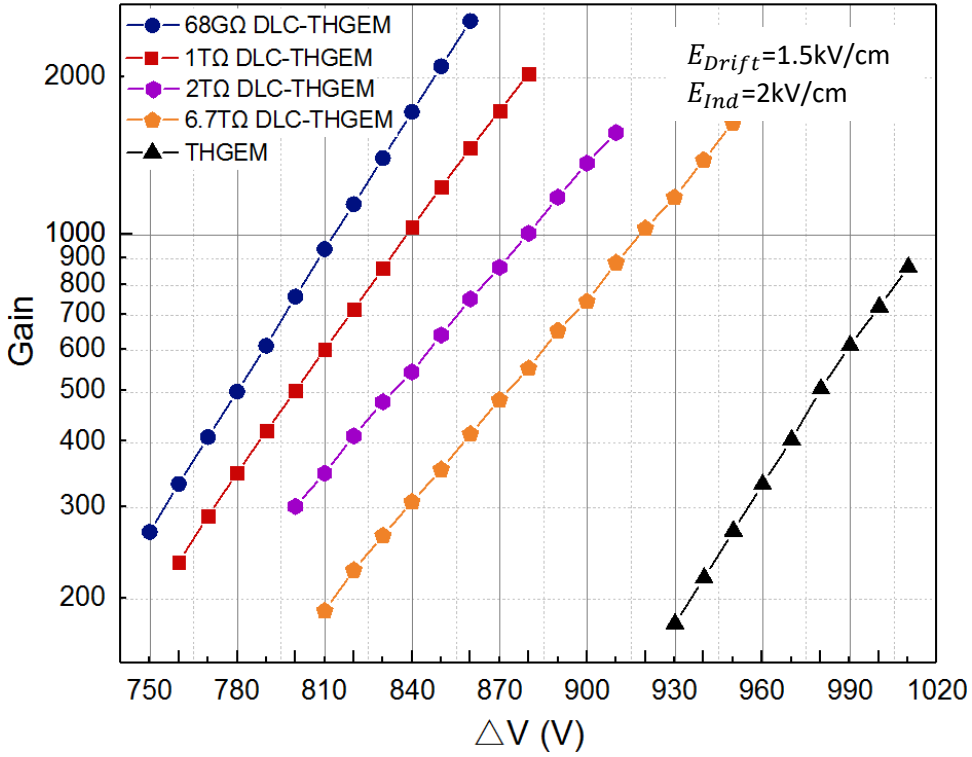


(d) Gain and energy resolution versus $E_{Inddution}$

✓ Basic properties of DLC-THGEM are similar to normal THGEM

Preliminary Results

- **Gain of DLC-THGEM**



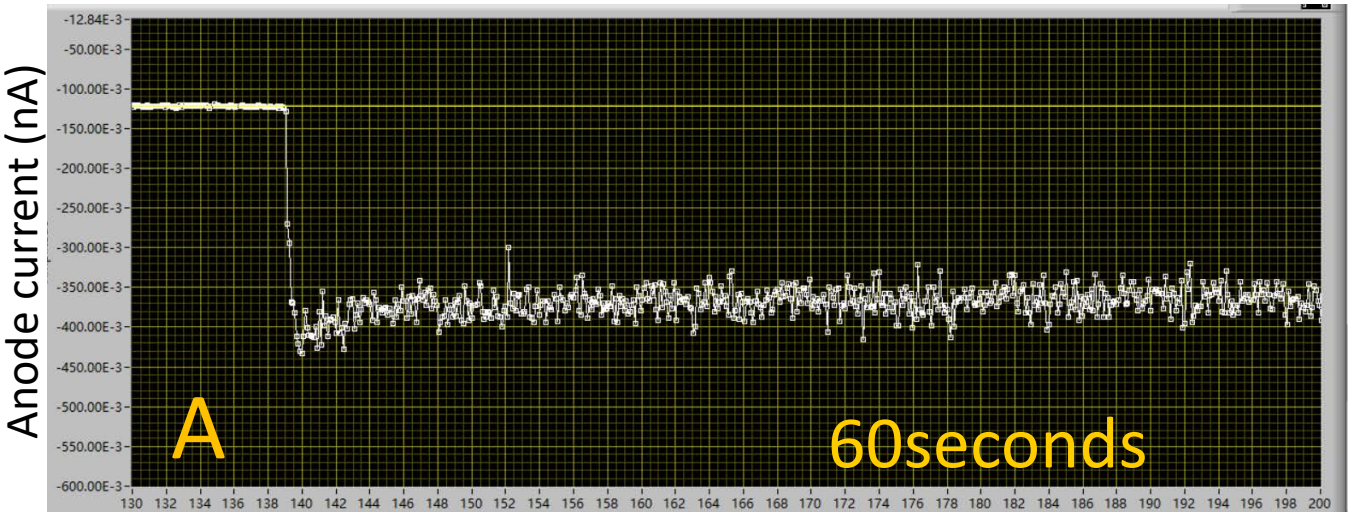
- ✓ DLC-THGEM achieved higher maximum gain compared with normal THGEM;
- ✓ DLC-THGEM achieved higher gain at lower voltage ;
- ✓ To achieved same gain, DLC-THGEM with lower resistance needs lower voltage.
- ✓ DLC layer modified THGEM electric field. To understand this effect, calculations and simulations are needed.

Time evolution of Gain

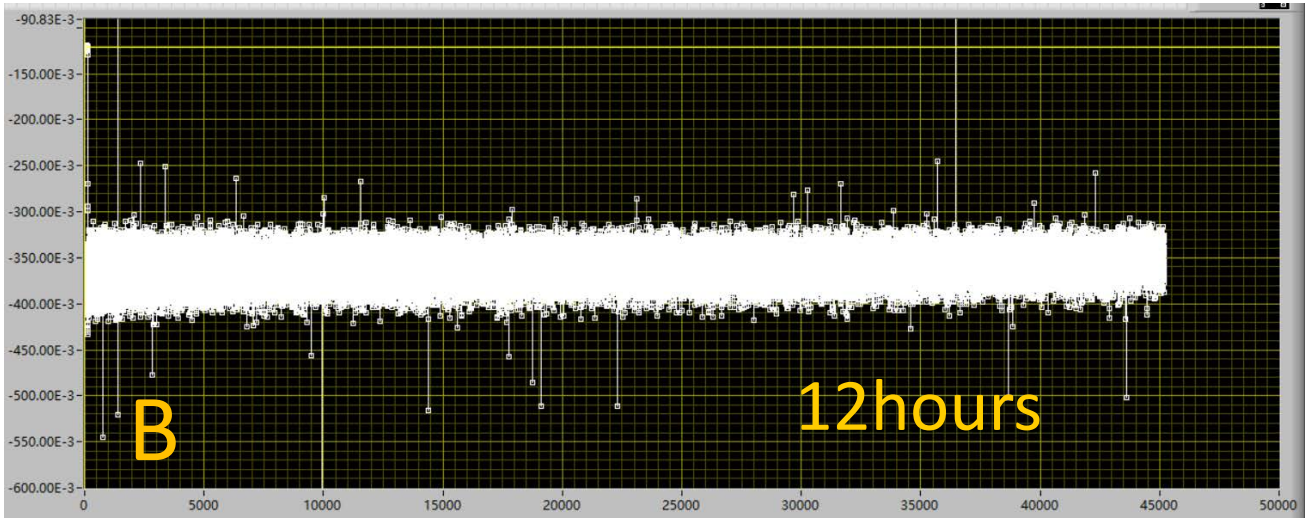
- 1TΩ DLC-THGEM

E_D=1.5kV/cm,
E_{Ind}=2kV/cm
$\triangle V_{THGEM} = 810V$

- $Fe55$ source~$\boldsymbol{70Hz/mm^2}$



- ✓ No significant anode current decrease or rise observed in 12 hours.
- ✓ Current variation smaller than 5%.

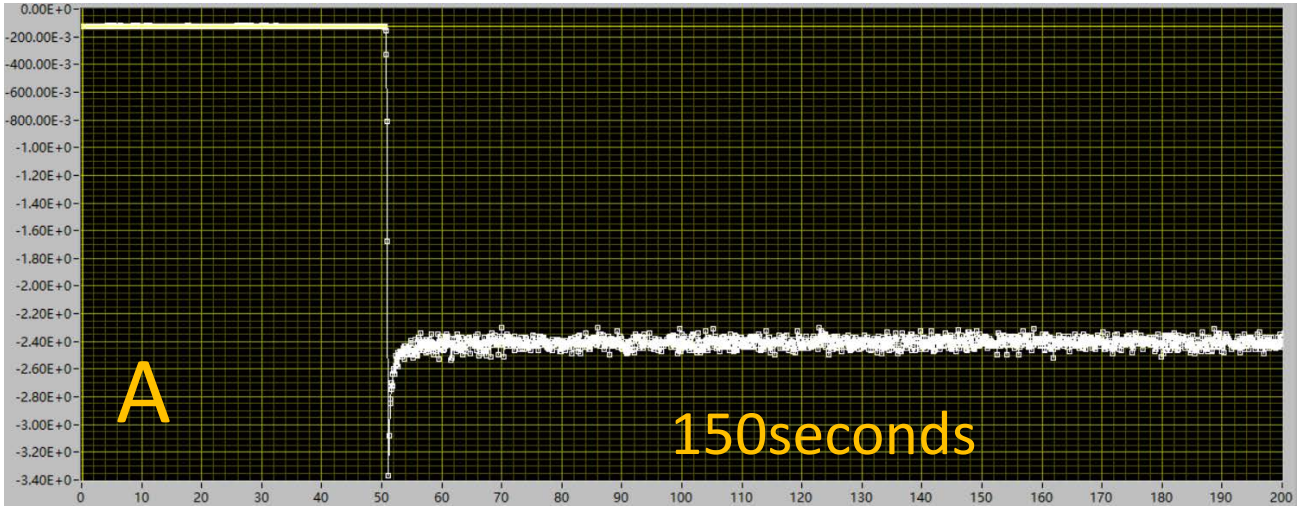


Time evolution of Gain

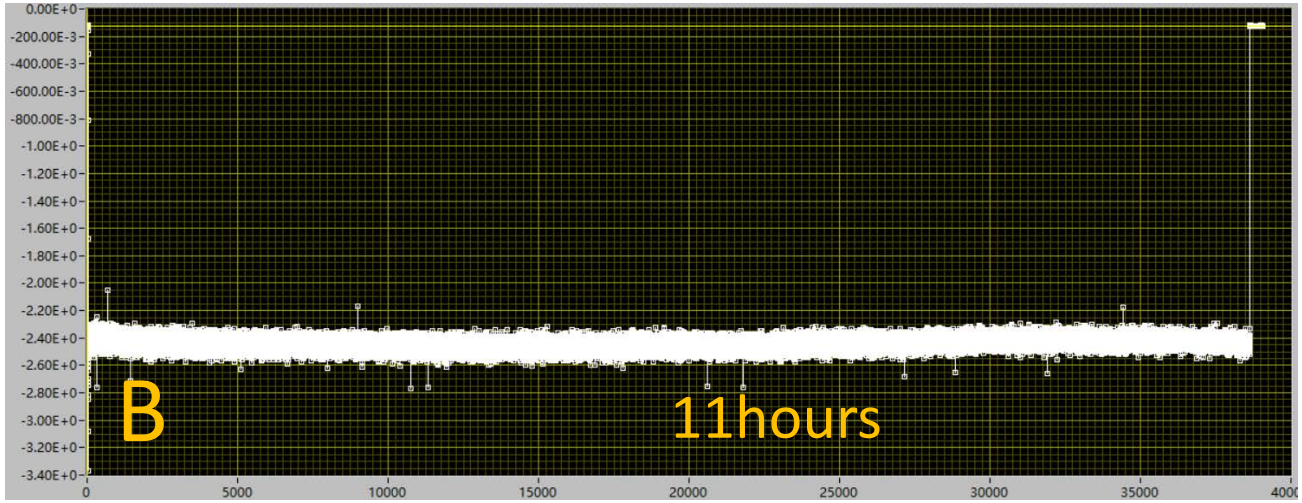
- 1TΩ DLC-THGEM

E_D=1.5kV/cm,
E_{Ind}=2kV/cm
$\triangle V_{THGEM} = 810V$

- $8keV\ Xray \sim \mathbf{10kHz/mm^2}$



- ✓ No significant anode current decrease or rise observed in 11 hours.
- ✓ Current variation smaller than 5%.

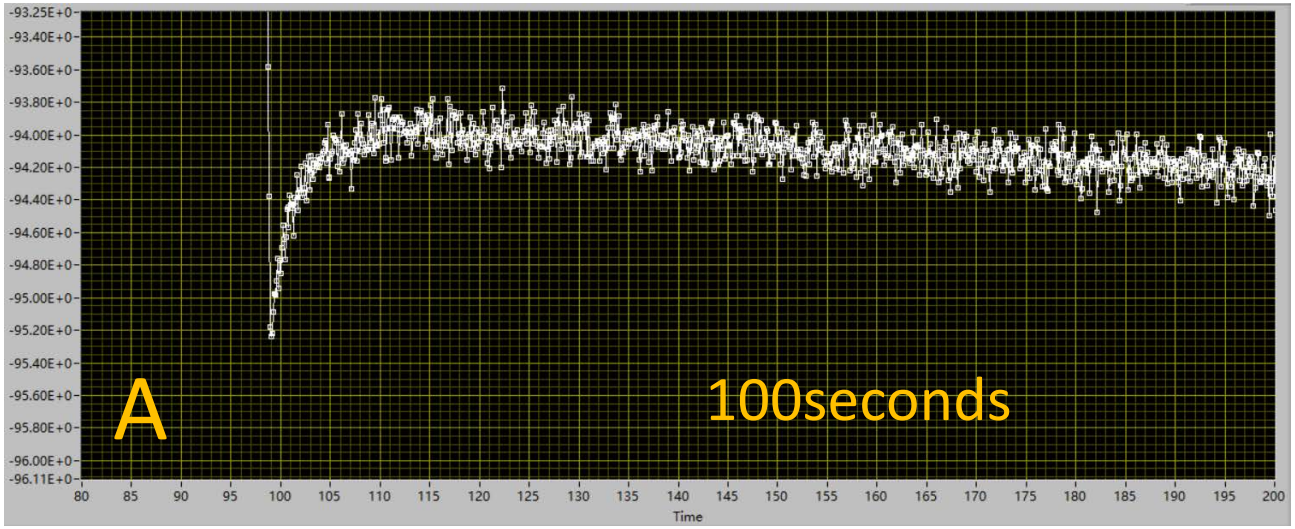


Time evolution of Gain

- 1TΩ DLC-THGEM

E_D=1.5kV/cm,
E_{Ind}=2kV/cm
$\triangle V_{THGEM} = 810V$

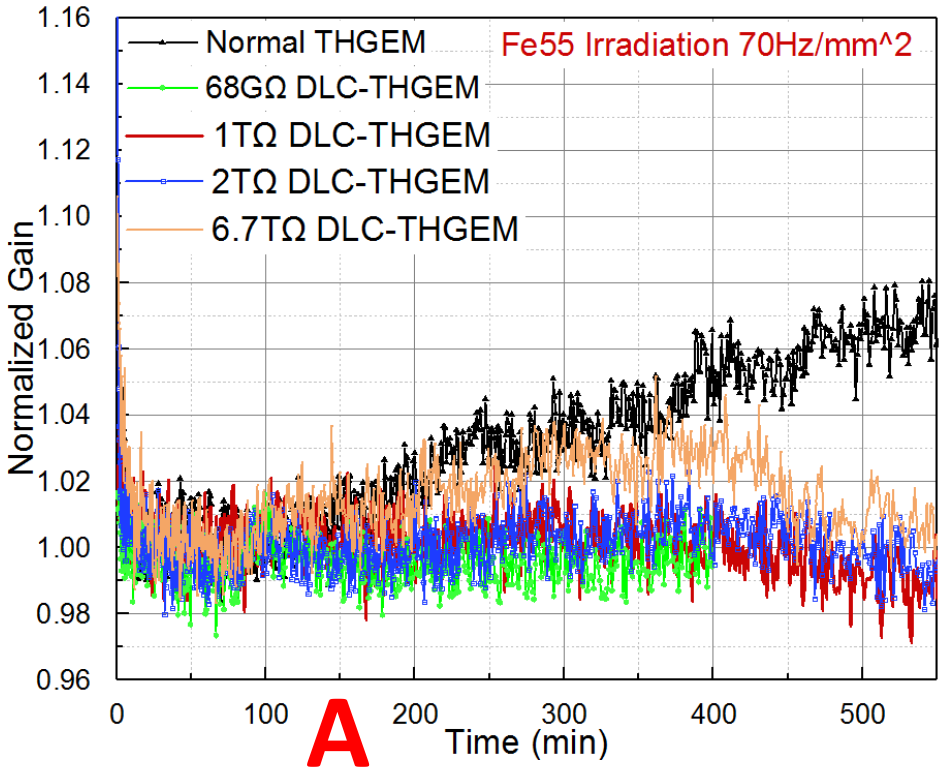
- 8keV X-ray~$\boldsymbol{400kHz/mm^2}$

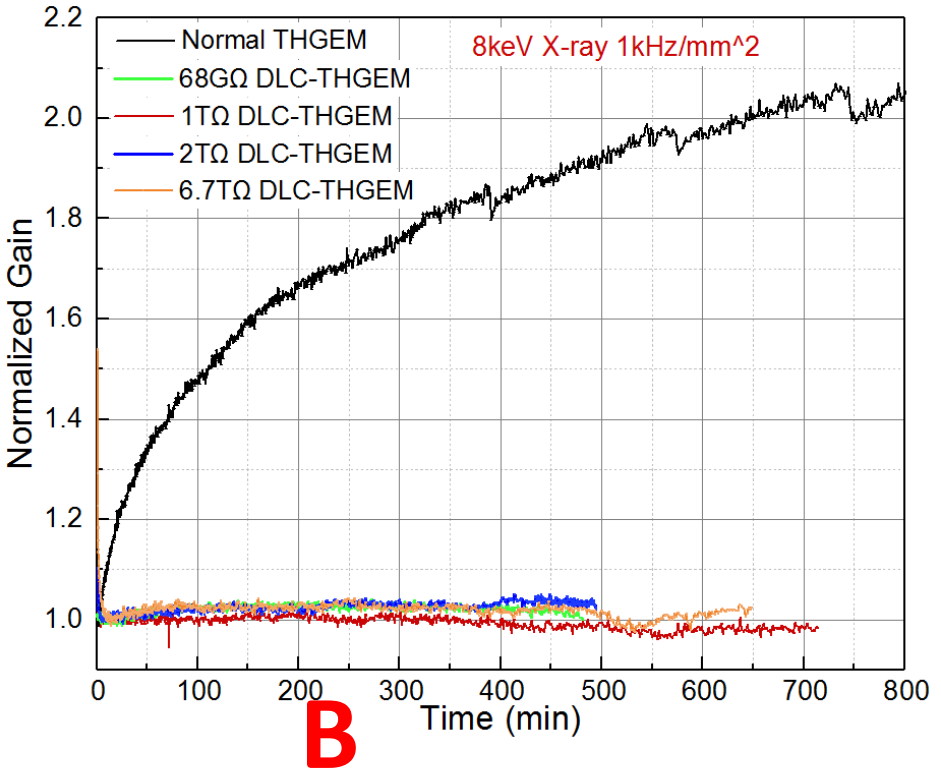


✓ Anode current increased by 12% in 12 hours at very high irradiation rate.

Time evolution of Gain

- Gain evolution of a series of DLC-THGEM and normal THGEM

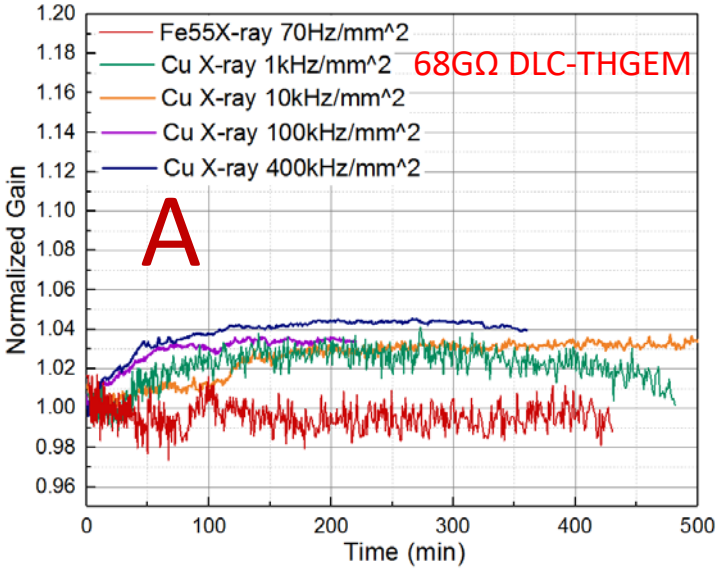


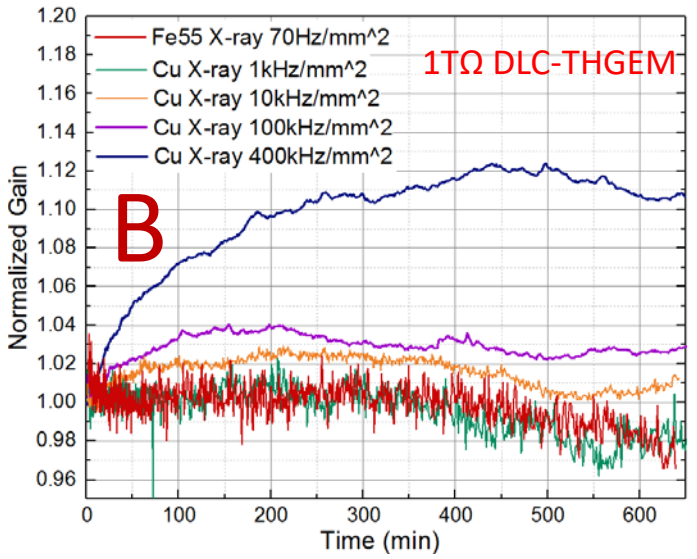


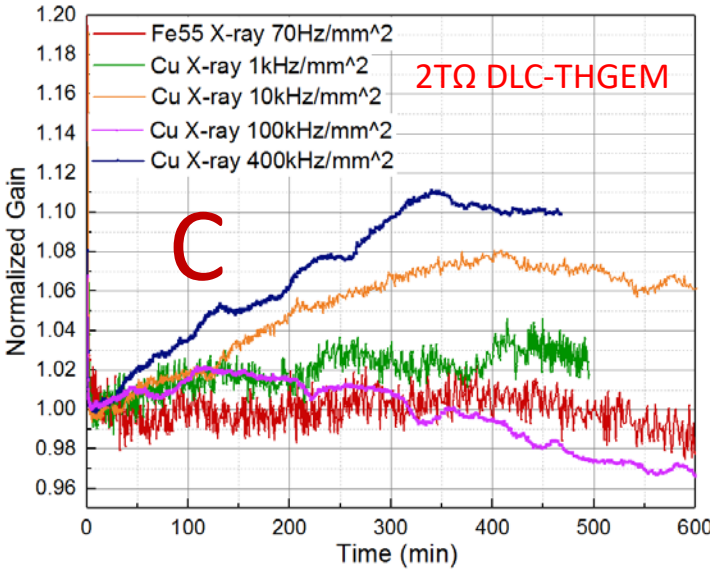
- ✓ Short term charging-up Gain decrease less than 10%
- ✓ Long term charging-up removed.

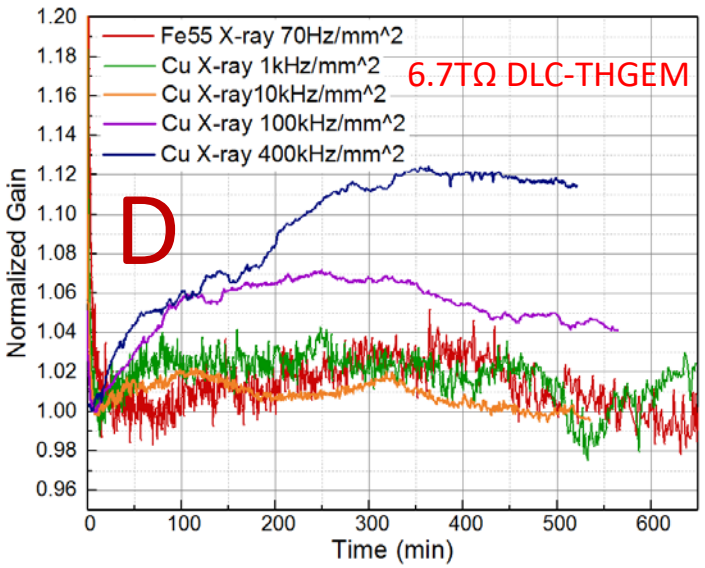
Time evolution of Gain

- Gain evolution of DLC-THGEMs at different irradiation rates.









- ✓ Gain variation <5% when irradiation rate <100kHz/mm^2.
- ✓ DLC-THGEM with lower resistance shows smaller Gain variation.

Summary

- Single-layer DLC-THGEM detectors have been tested in different working conditions.
- DLC-THGEM shows good gain stability and no significant charging-up effect compared to the standard THGEM up to the rate 100kHz/mm^2.
- Lower resistance DLC-THGEM is able to achieve higher gain at even lower voltage compared to the standard THGEM.
- The gain of DLC-THGEM decreases quickly while the irradiation rate increases.

Future work

1. Other properties such as aging effects, gain uniformity, spatial resolution will be tested;

2. To understand how the DLC layer affects the detector physics, the MC study on THGEM will be performed;

3. Improving the rate capability, try resistive THGEM and fast grounding THGEM.

THANK YOU !