Measurement of basic feature of Thick-GEM & Resistive-GEM

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Thick-GEM (New type of GEM)

■ Motivation

GEM is a good device and applied to many detectors.
But, there are some defects, so the application is restricted.
ex.) Low-pressure TPC
50μm-GEM → cannot achieve high gain at low pressure (100Torr)

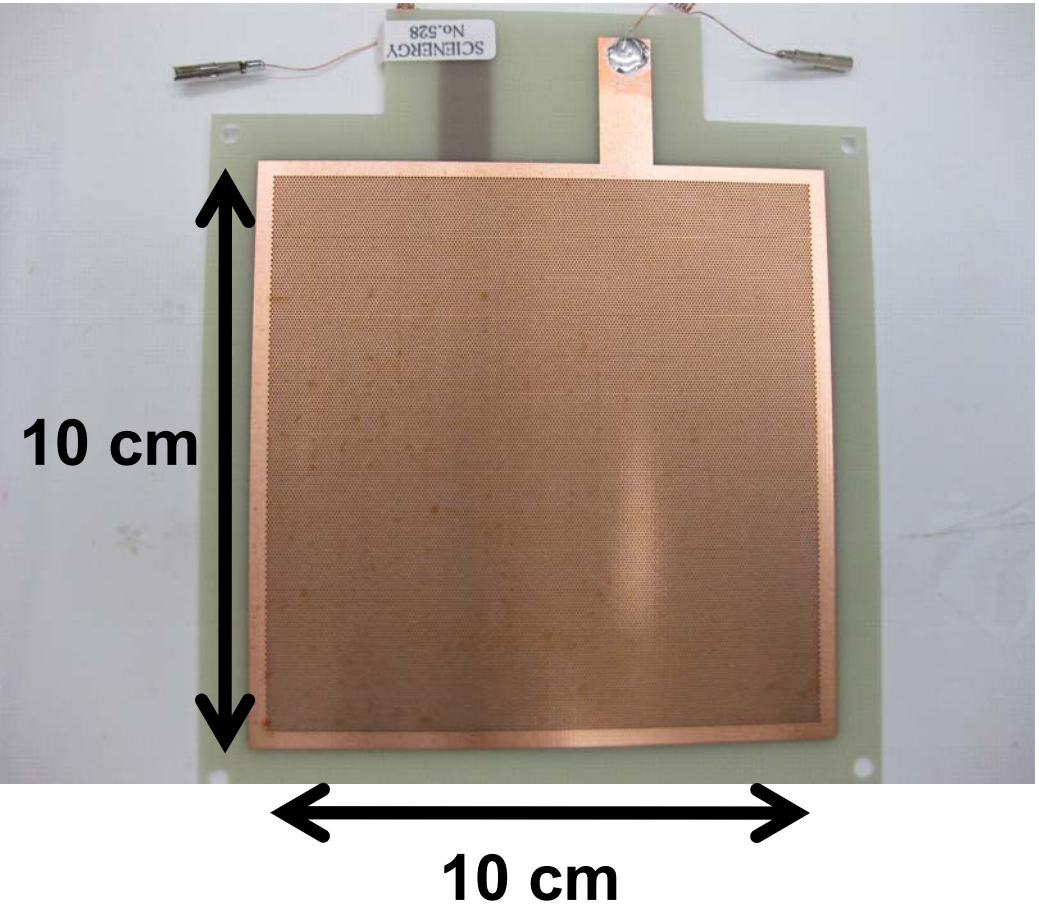
■Thick-GEM

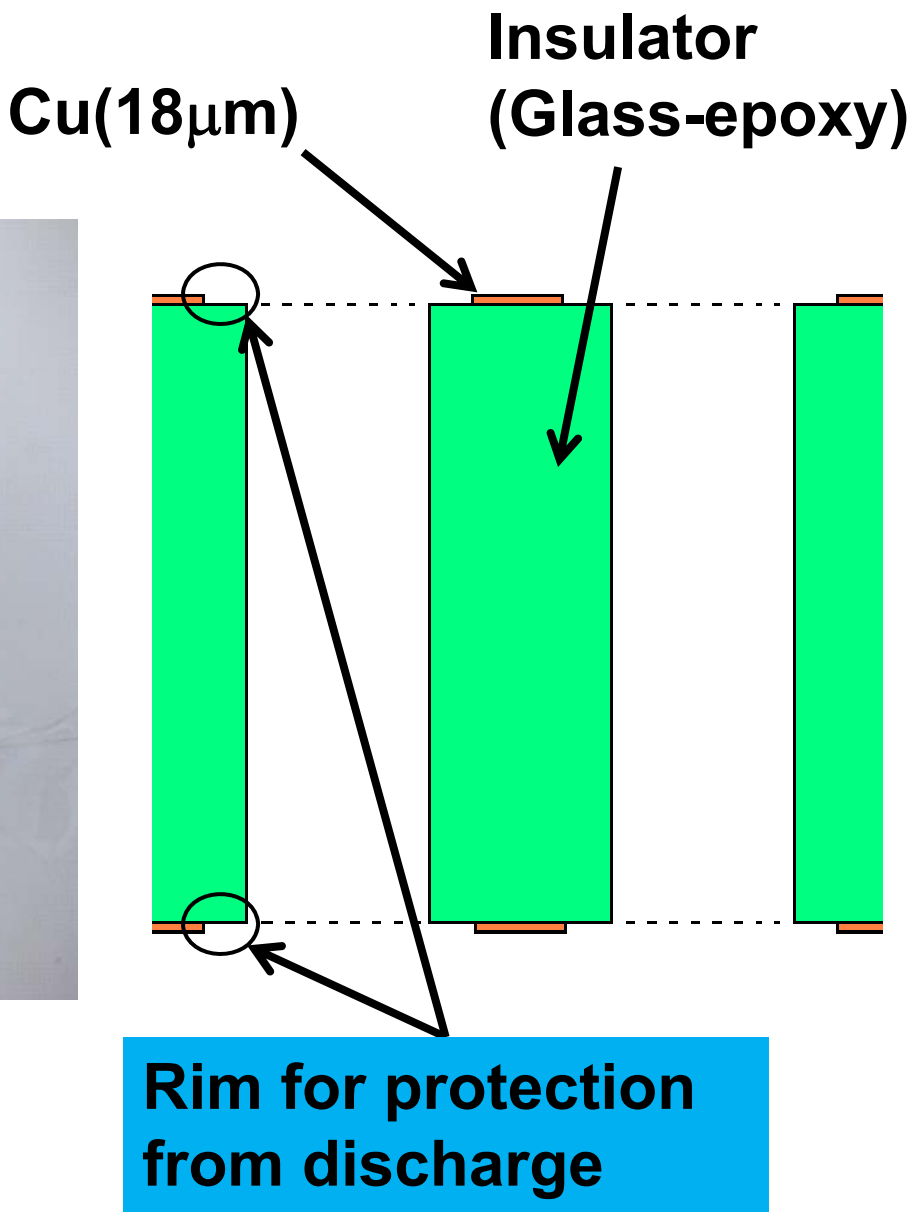
Recently, mille-meter scale GEM(**Thick-GEM**) has developed.

- **Robustness against discharge**
- **Achieve high gain at low pressure**
- **Easy to make**

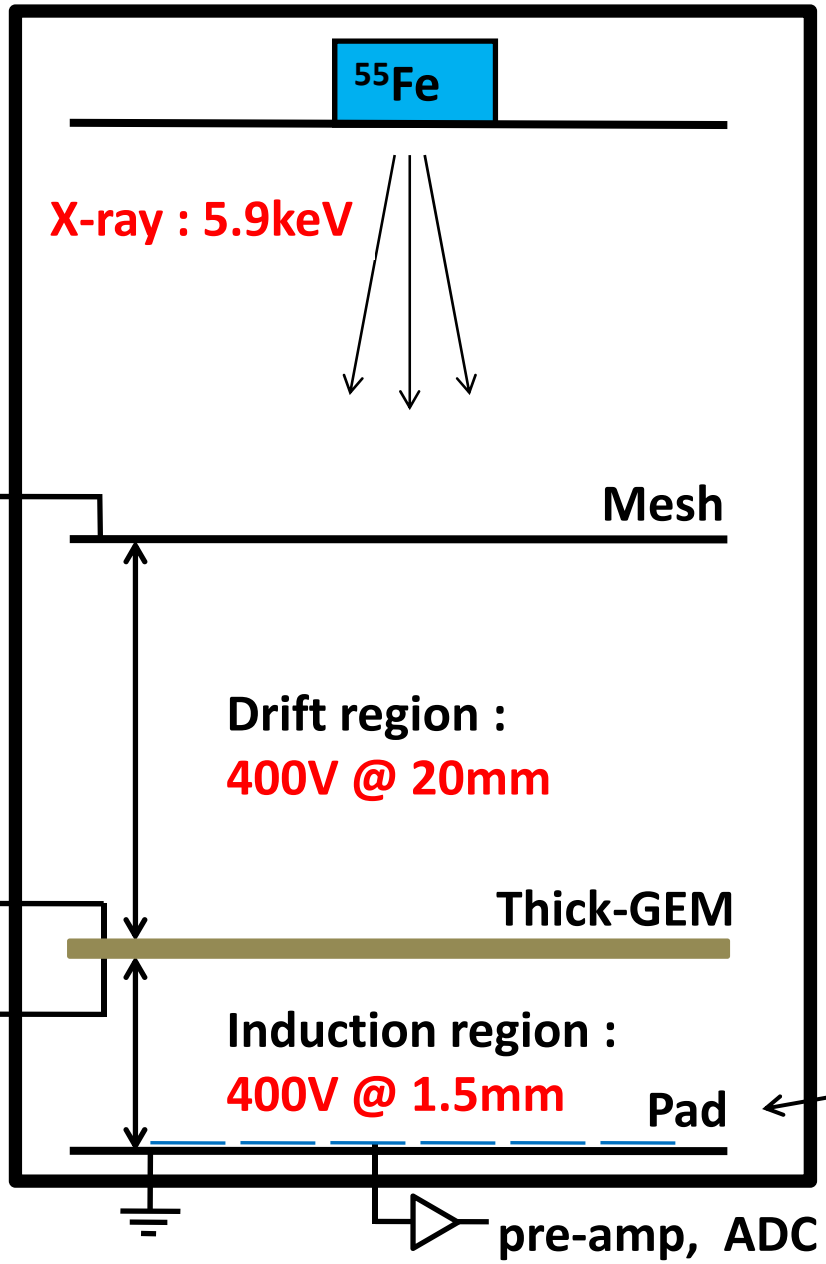
Thick-GEM is very interesting detector, but its basic feature is not studied well. So we made several type of Thick-GEM and studied its basic feature.

- **Gain vs. Voltage supplied at GEM(ΔV_{GEM})**
- **Stability of gain**
- **Energy resolution**


SCIENERGY
No.528
10 cm
10 cm


Cu(18μm)
Insulator
(Glass-epoxy)
Rim for protection
from discharge

Setup



: 20MΩ

- Gas : P10 (Flow)
- Atmosphere
- Room temperature

1cm × 1cm

Thick-GEM (thickness/diameter)

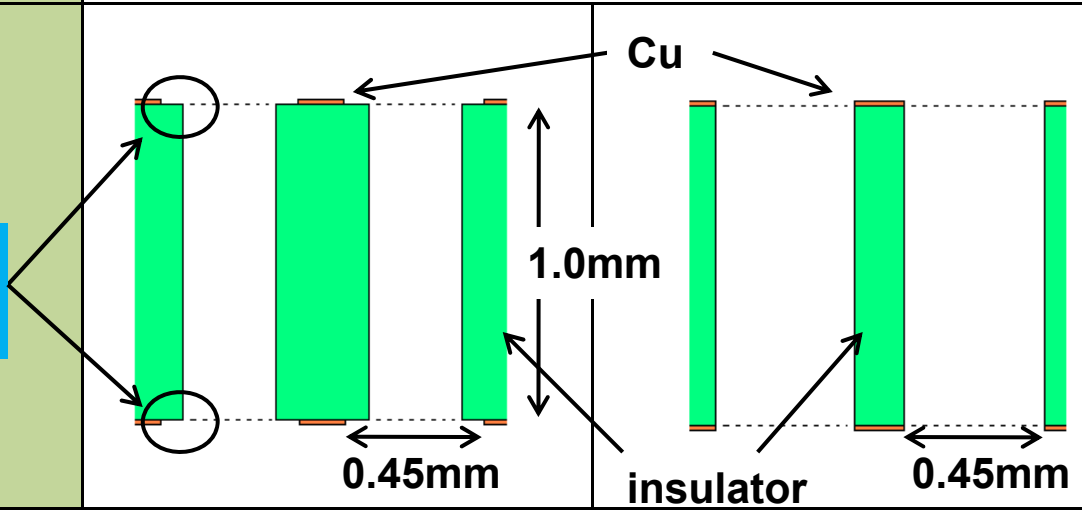
Thick-GEM	#01	#02	#03	#04
Thickness(t)	0.5mm	1.0mm	0.5mm	1.0mm
Diameter of insulator(ϕ)	0.3mm		0.5mm	
Pitch	0.6mm		1.0mm	
Rim for protection from discharge	With(diameter of electrode is 0.15mm larger than that of insulator)			

#01, #03, #04 : Discharges start at gain ~ 10^3

#02 : Gain achieved around 10^4

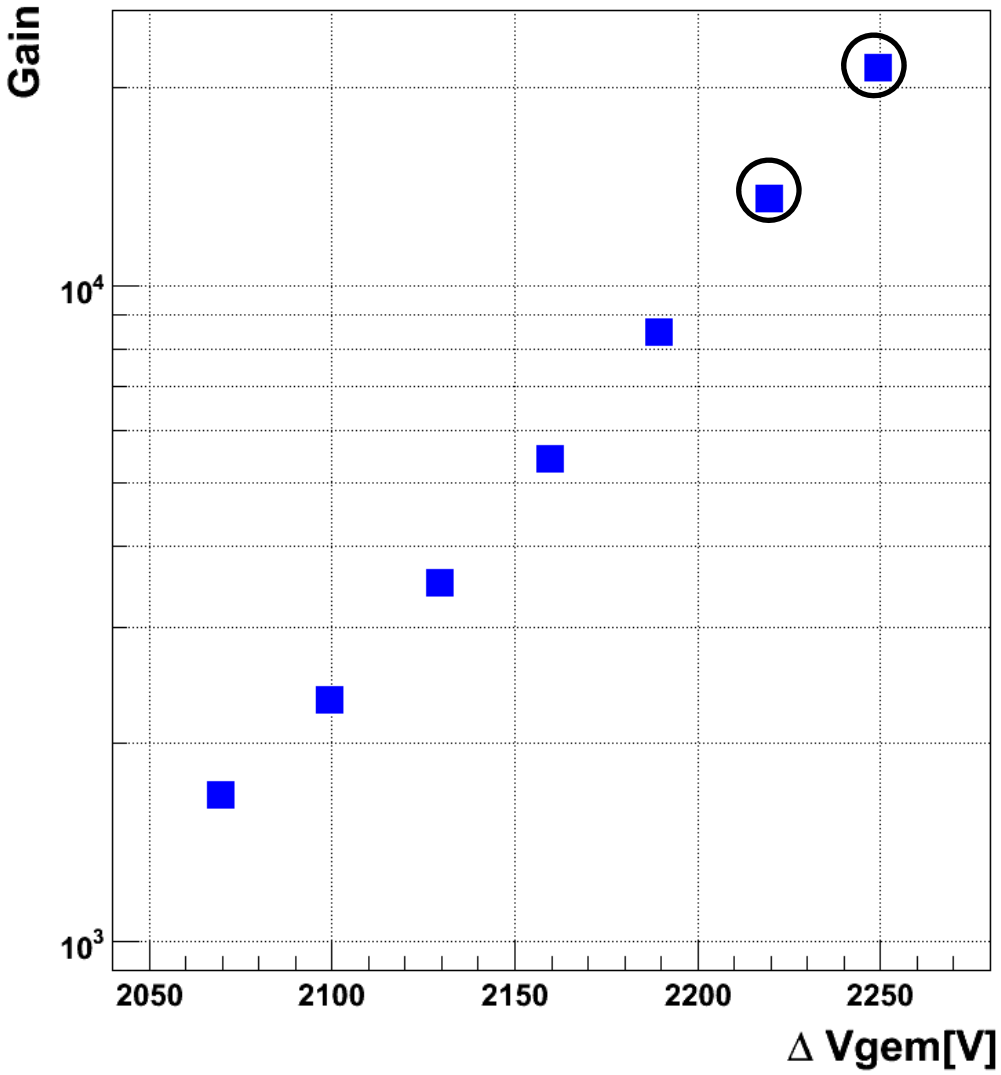
We study more about Thick-GEM with t:1.0mm, ϕ:0.3mm.

Thick-GEM (with/without rim)

Thickness	1.0mm	
Rim against discharge	With	Without
Diameter of insulator	0.3mm	0.45mm
Diameter of electrode	0.45mm	
Pitch	0.6mm	
Rim for protection from discharge		

Thick-GEM without rim : Discharges start at gain ~ 10^3

Gain

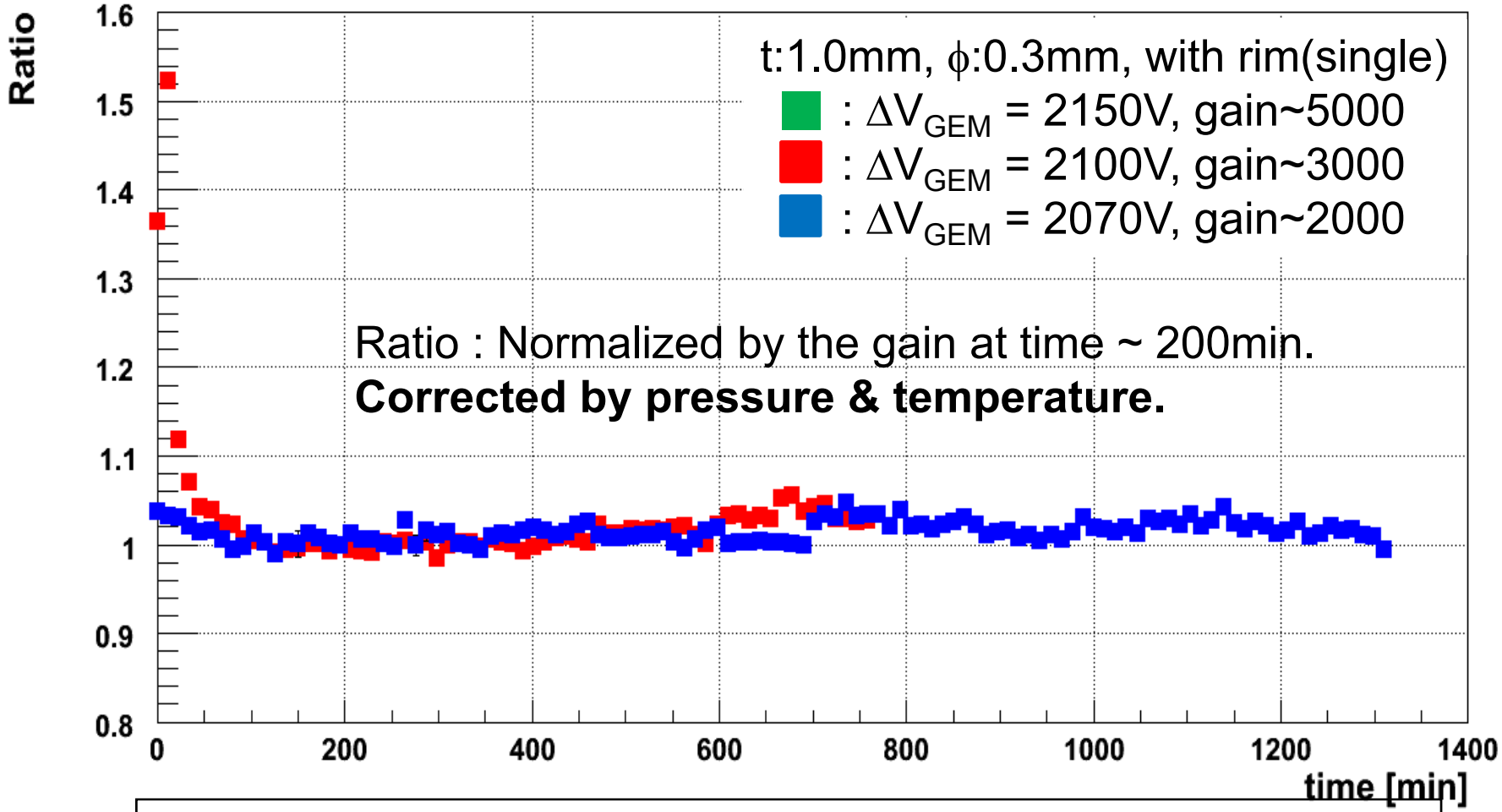


■ : t:1.0mm, ϕ:0.3mm, with rim

○ : Discharge (more than1 time/min)

Gain ~ 10^4 achieve

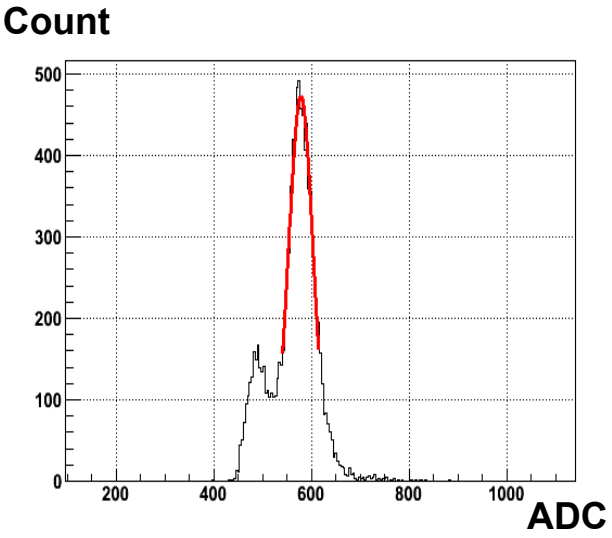
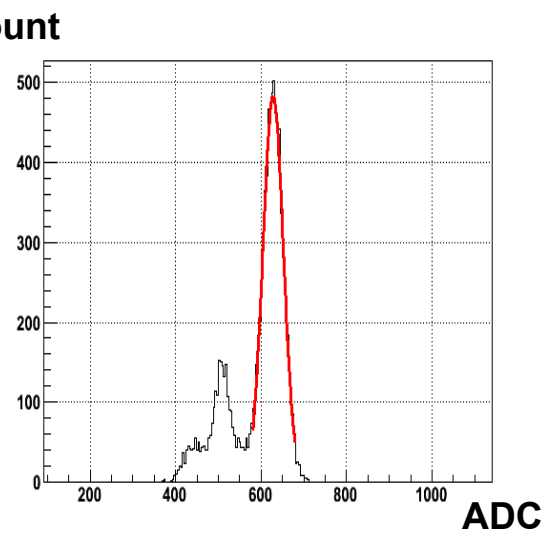
Stability



- Gain **increase** → stability **gets worsen**.
- **At first few hours**, gain drops down.
- After that, the fluctuation of gain is within **±4%.**

Energy resolution

- Number of event : 10000
- Gain~2×10^3

	Thick-GEM	50μm-GEM
	single	triple
Energy resolution (σ)	**13%**	**10%**
ADC distribution		

Energy resolution ~ 13% (Thick-GEM with rim)

Resistive-Thick-GEM

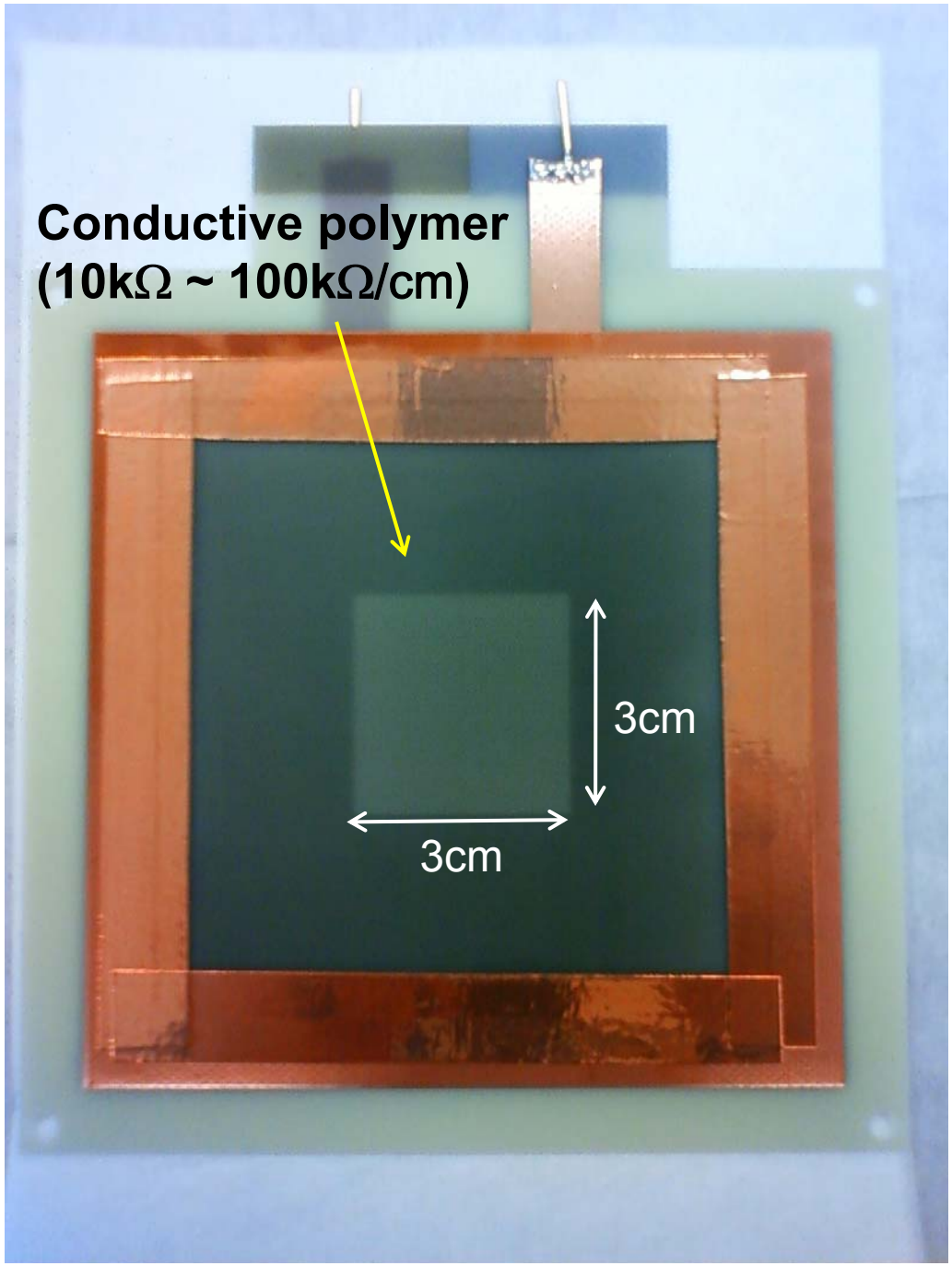
■ Thick-GEM : **Not stable** @ high gain(< 5000)

■ Electrode has **high resistivity,** made of conductive polymer.(**Resistive-Thick-GEM**)

→ To lessen the effect of discharge

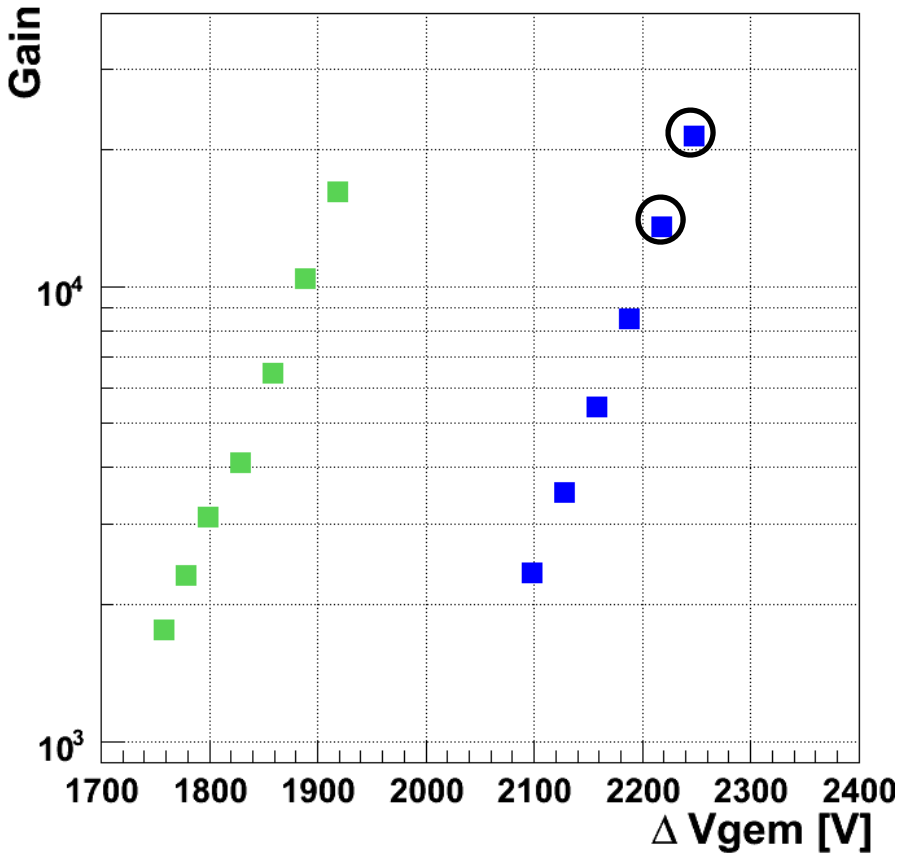
■ Owing to the high resistivity, when discharge happens and current flows inside the holes of GEM, electrodes consume the power of discharge and protect GEM.

■ Furthermore, **material budget is smaller** than that of **metal**. (The electrodes made of organic compound)



Thickness	1.0mm
Diameter	0.3mm
Pitch	0.6mm
Rim against discharge	Without

Gain



■ : Thick-GEM (t:1.0mm, ϕ:0.3mm, with rim)

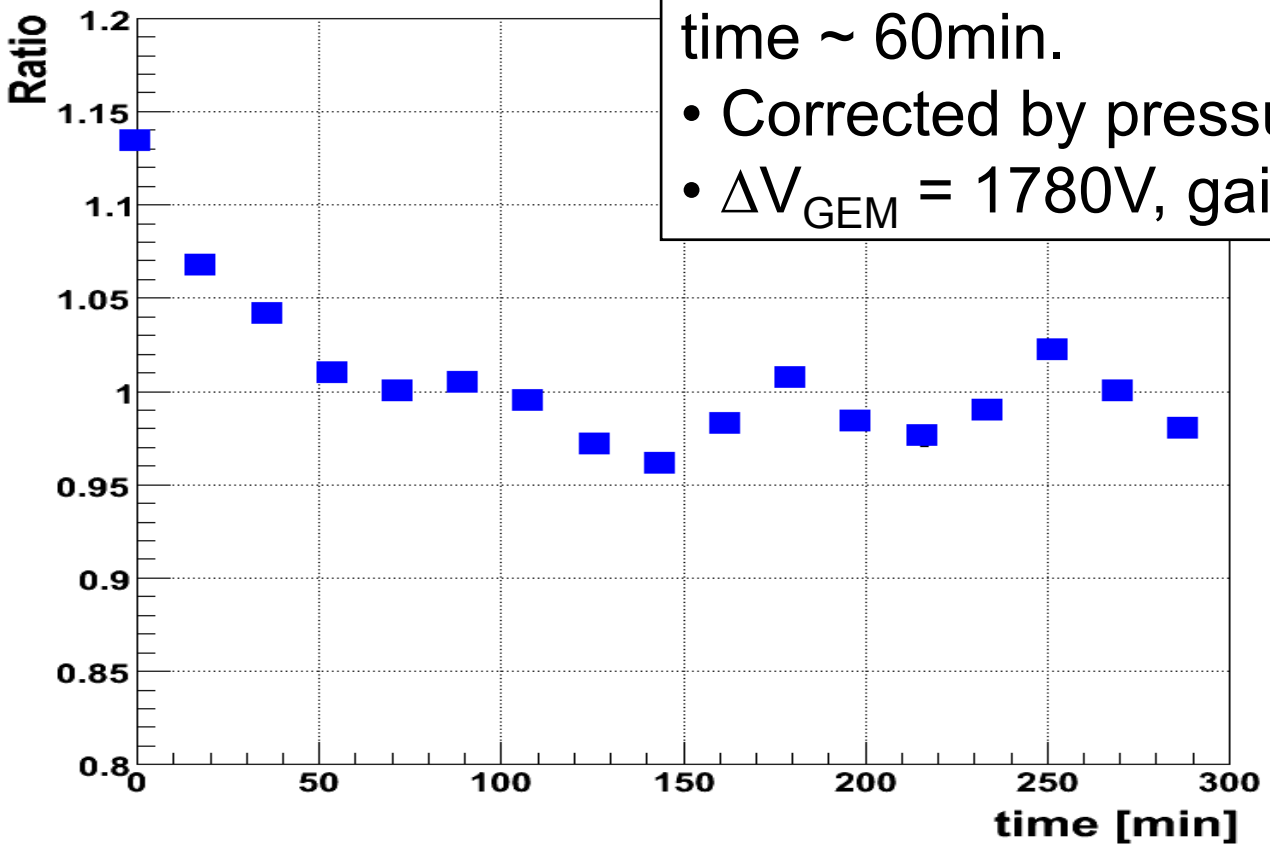
■ : Resistive-Thick-GEM

○ : Discharge (more than1 time/min)

Maximum gain : Resistive-Thick-GEM > Thick-GEM

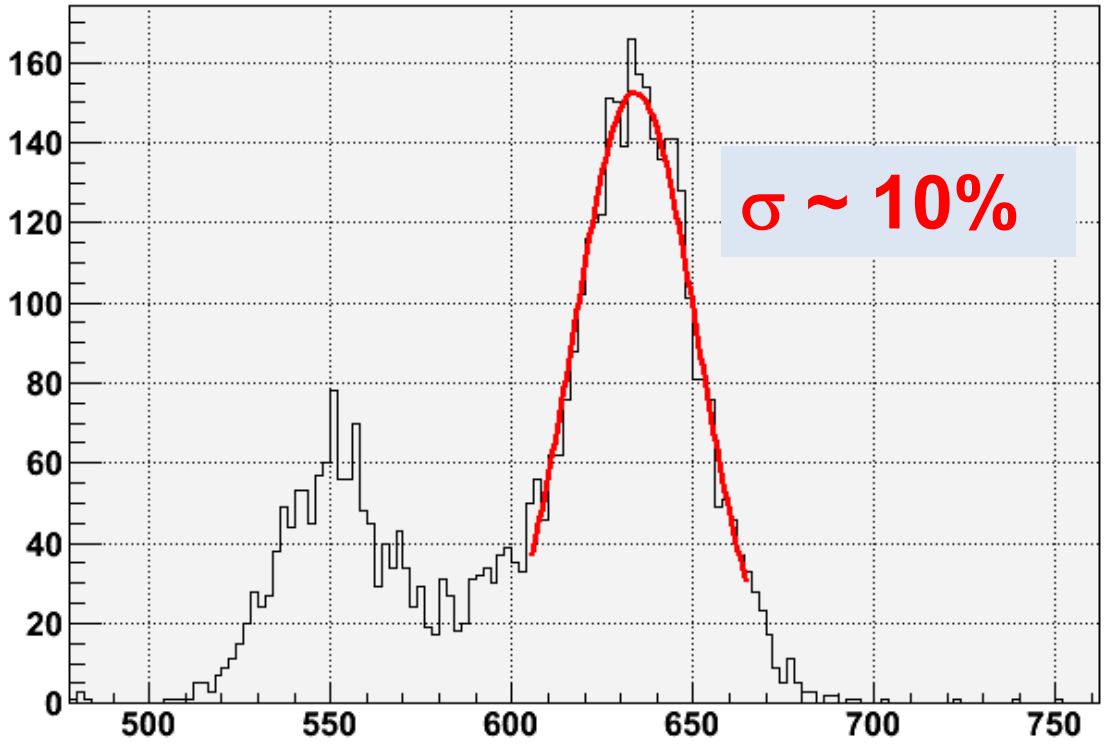
Stability

- Ratio : Normalized by the gain at time ~ 60min.
- Corrected by pressure & temperature.
- ΔV_{GEM} = 1780V, gain ~ 2500



At first, gain drops down
After that, gain fluctuation is within **±4%.**

Energy resolution



ΔV_{GEM} = 1780V
Gain ~ 2500

- **Better than Thick-GEM.**
- **Comparable to triple 50μm-GEM.**

Summary1

■ Thick-GEM

Make several geometry of Thick-GEM.(Thickness, diameter, rim)

→ The Maximum gain : **t:1.0mm, ϕ:0.3mm, with rim.**

→ We study more about Thick-GEM with this geometry.

- Gain
  - ~**10^4** achieved.
- Stability
  - At low gain (< 5000)
    For the first few hours, gain **drops down,** after that, **±4%**.
  - At high gain (>5000)
    The fluctuation is **not too small**.
- Energy resolution(σ)
  - ~**13%** (single; gain:~2000), (triple 50μm-GEM:~10%)

➢ At **Low** gain (<5000) : **Good** performance

➢ At **High** gain (>5000) : Performance **gets worsen.**

Summary2

■ Resistive-Thick-GEM

To achieve good performance at high gain, we also study Resistive-Thick-GEM.

- Gain
  - **> 10^4**, which is larger than **Thick-GEM.**
- Stability
  - For the first few hour, gain **drops down.**
  - After that, **±4%.**
- Energy resolution(σ)
  - ~ **10%** (single)
  - **The same level** with **triple 50μm-GEM.**

Outlook

- Stability at **higher gain** and for **long time** for Resistive-Thick-GEM.

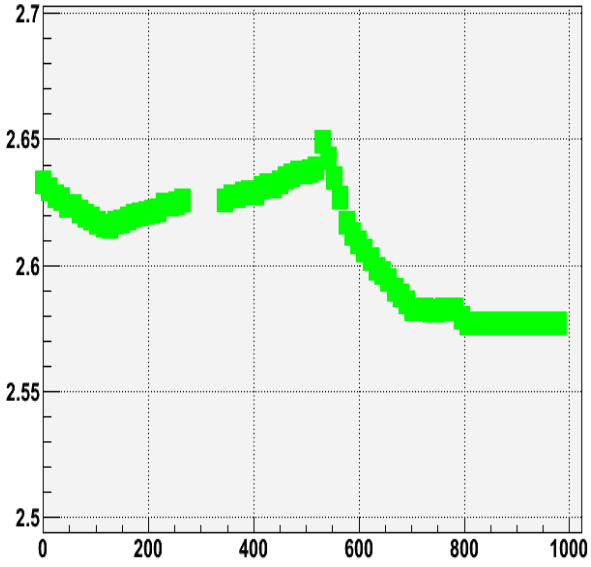
- To study the difference of the performance of Thick-GEM with rim and that of Resistive-Thick-GEM, more study for **Thick-GEM without rim**.

- Performance at **high rate**.

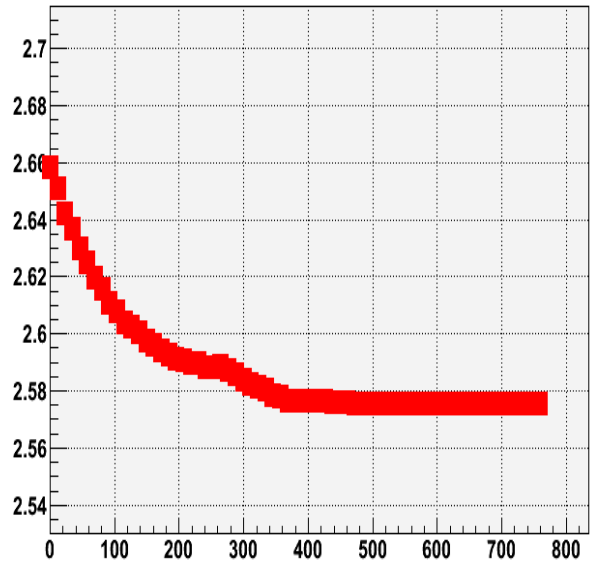
END

Backup

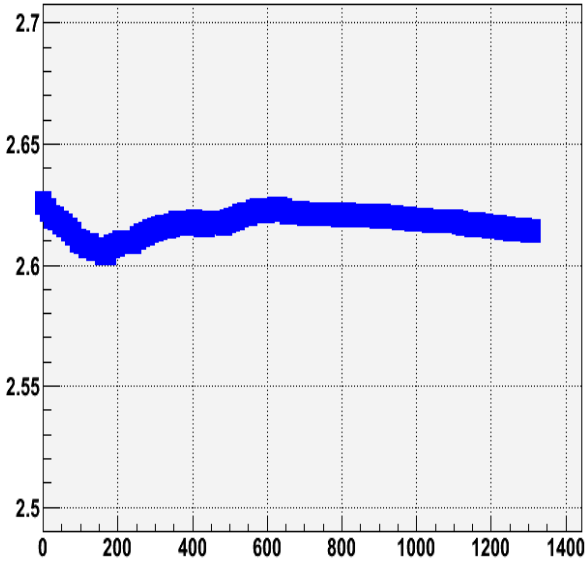
P/T distribution



ΔV_{GEM}=2150V

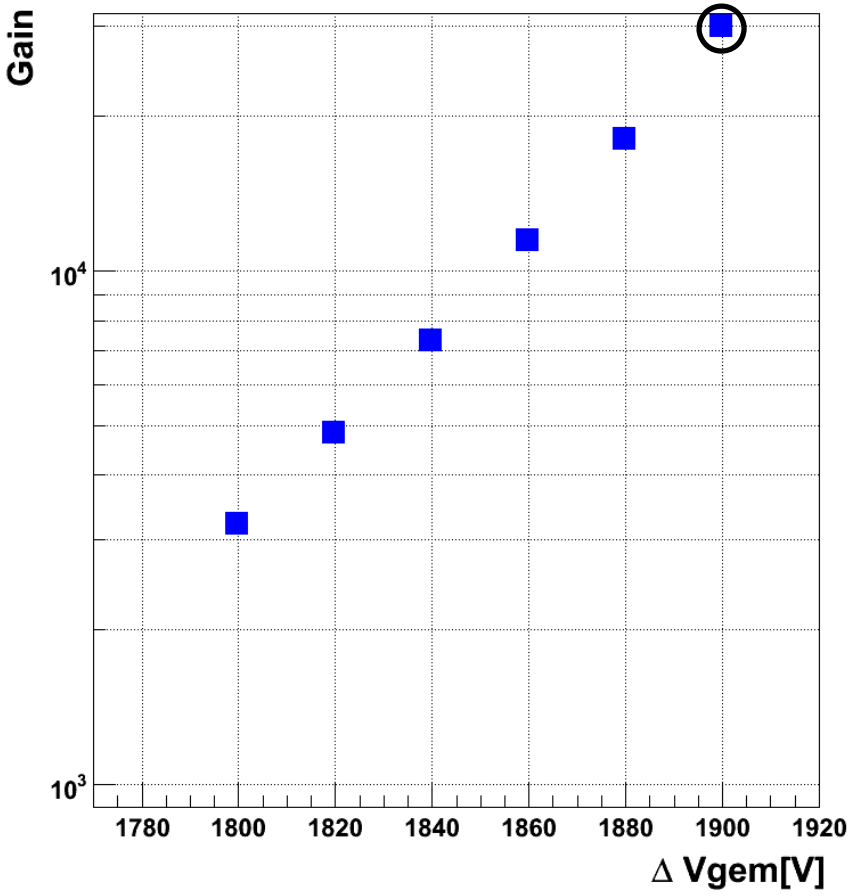


ΔV_{GEM}=2100V

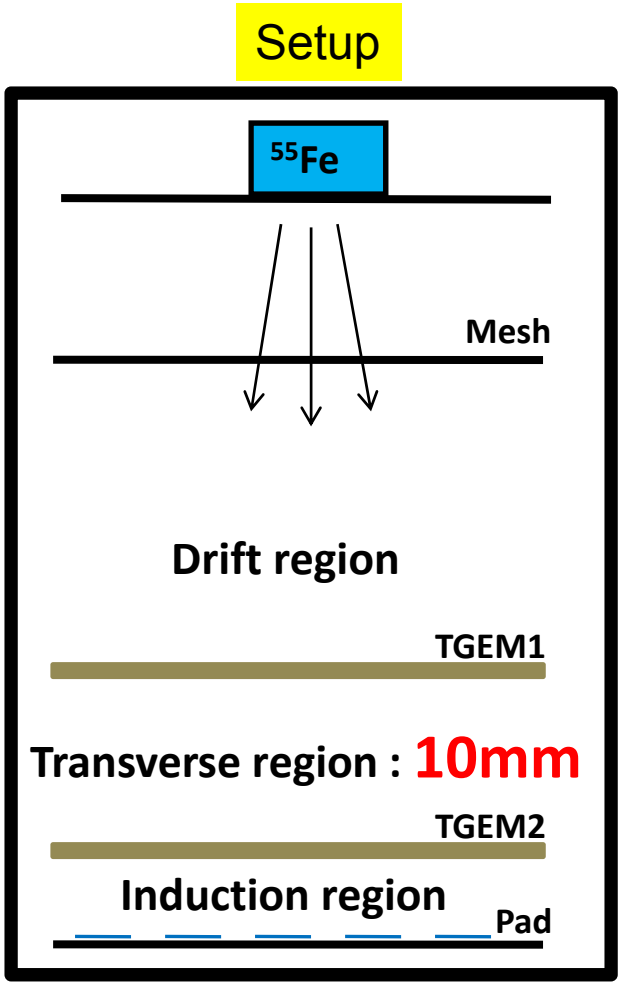


ΔV_{GEM}=2070V

Gain ~double~



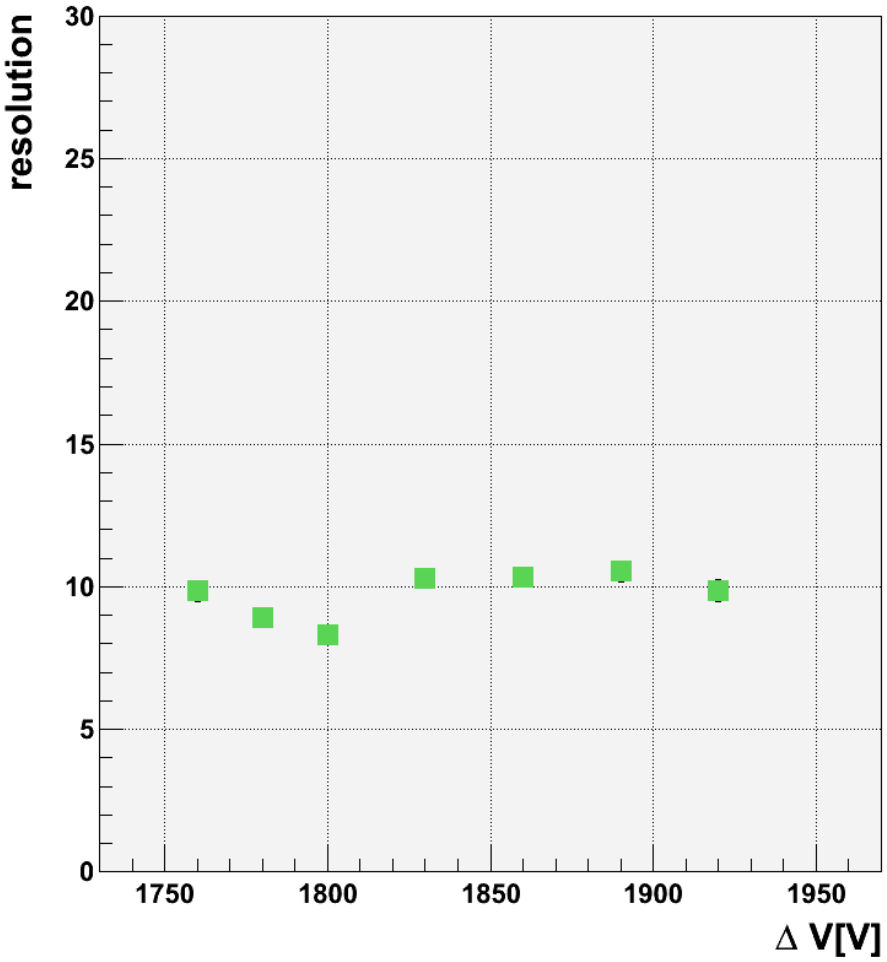
Maximum gain ~ 2X10^4



■ : With rim; double(length between TGEM is 10mm)

○ : Discharge (1 time/min)

Energy resolution at several ΔV_{GEM}



Energy resolution of Resistive-Thick-GEM at several ΔV_{GEM}

Pedestal run