R&D of Ceramic GEM

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What is Ceramic GEM ?

GEM sheet using LTCC as an insulator

LTCC (Low Temperature Co-fired Ceramics)

Ceramics is baked at low temperature (900℃)

→ Cu, Ag, and Au can be used electrode material
(Au plating is enable)

Advantage points

- bigger Gain (around 10000/one layer)
- good discharge resistance (prevent GEM from being broken due to discharge)
- rigidness (GEM supporting system can be simple)
- simple production process (cheap)

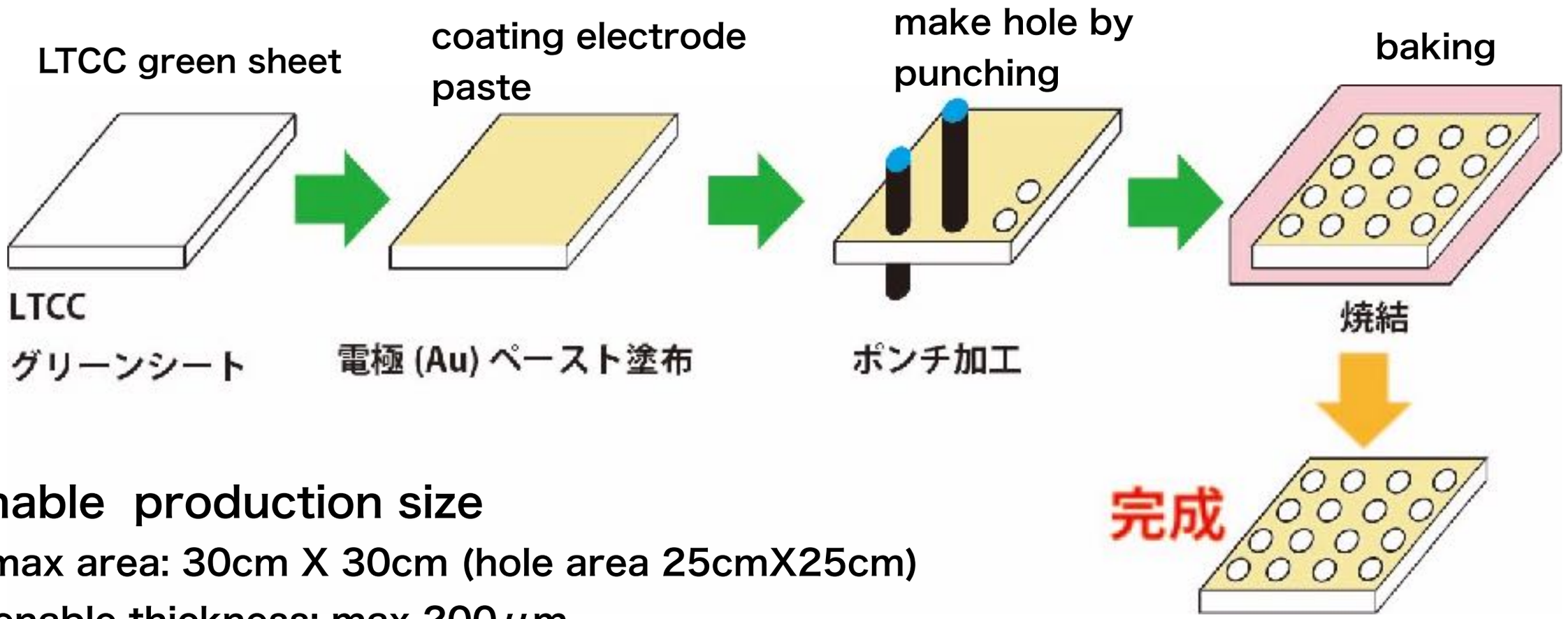
Property of LTCC material

材料		GCS71	GCS60	CS50
熱膨張係数	[10-6/K]	5.5	5.5	-
熱伝導	[W/m･K]	3.2	2.8	-
比熱	[J/g･K]	0.66	-	-
ヤング率	[GPa]	95	50	-
抗折強度	[MPa]	250	240	-
誘電率	@1MHz, R.T.	7.1	6.0	5.0
	@10 GHz, R.T.	7.1	6.0	5.0
誘電損失	@1MHz, R.T.	0.003	0.001	0.001
	@10 GHz, R.T.	0.005	0.001	0.001
体積抵抗率	[Ω･cm]	$>10^{14}$	$>10^{14}$	$>10^{14}$

How to make LTCC GEM

Production process

Product by Hirai Seimitsu Kogyo Corporation



Enable production size

- max area: 30cm X 30cm (hole area 25cmX25cm)
- enable thickness: max 200μm

LTCC GEM

Properties of LTCC-GEM

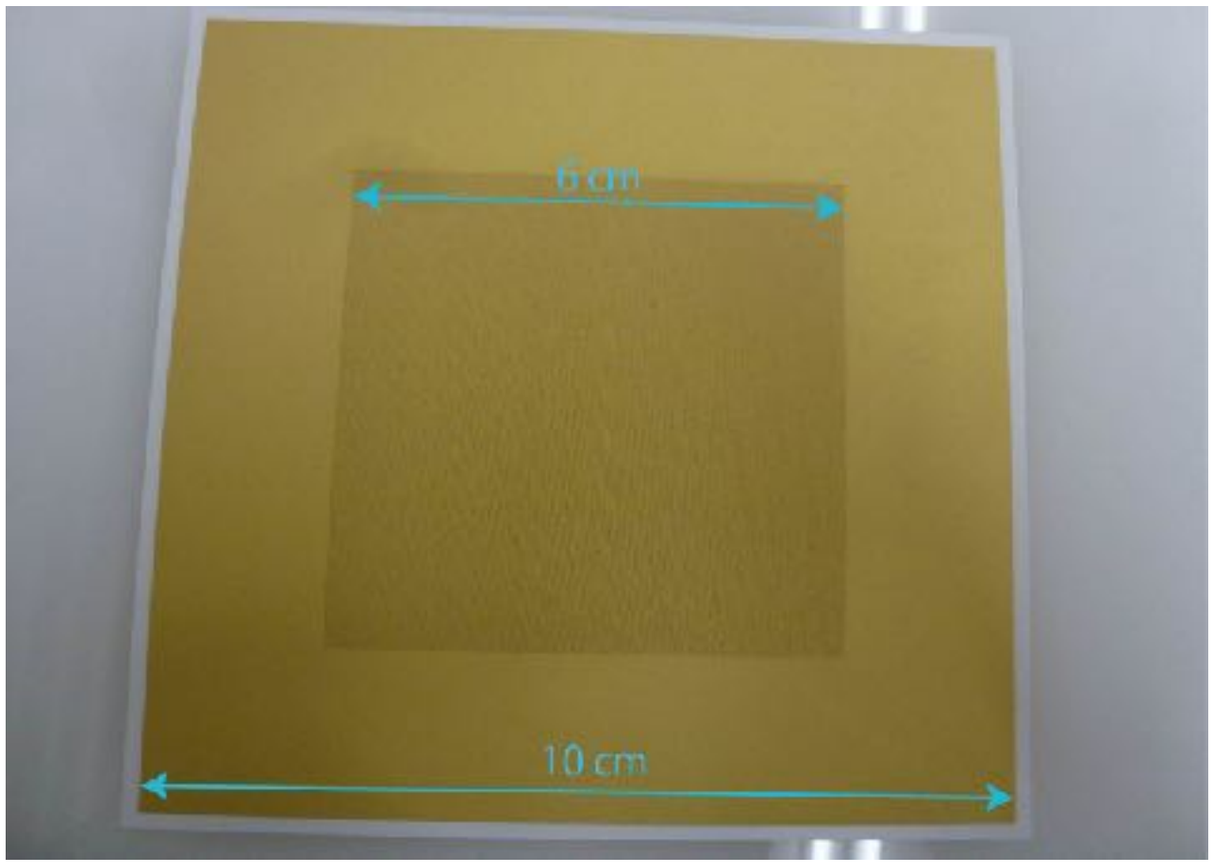
size：10cm X 10cm

hole area：6cm X 6cm

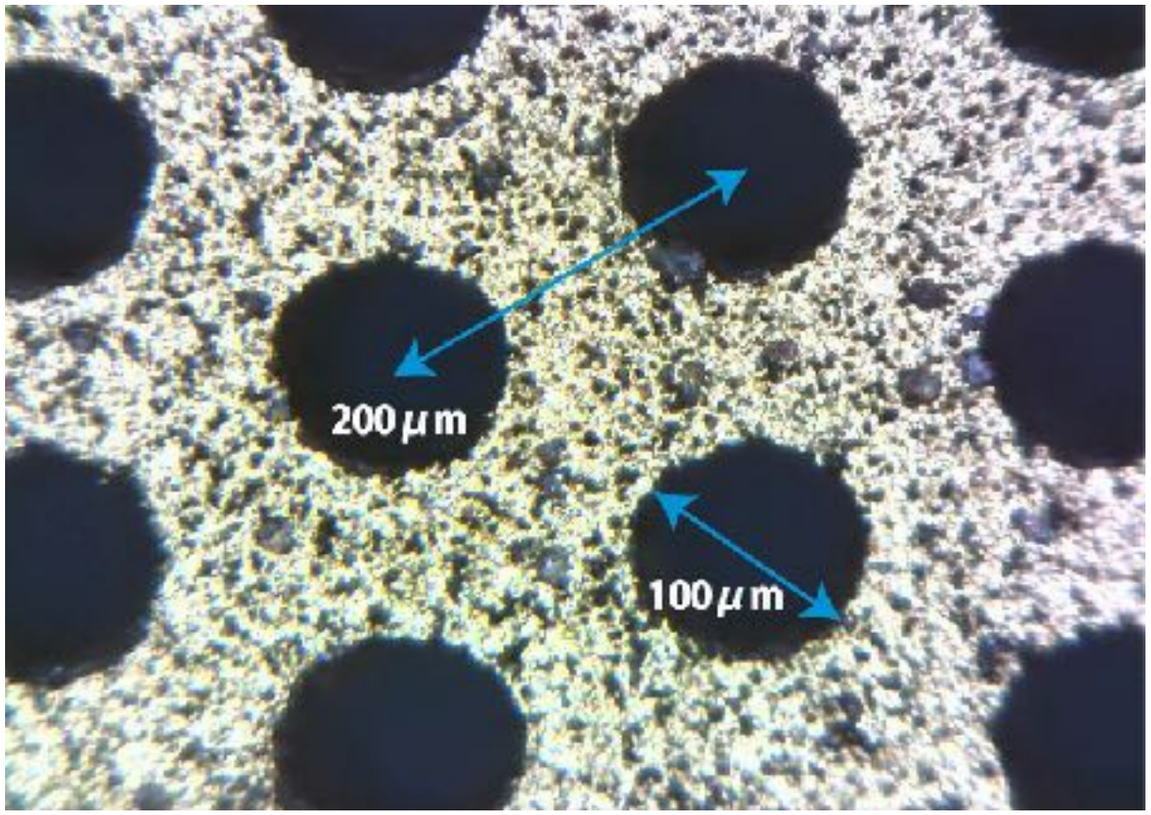
hole diameter：　100μm

hole pitch：200μm

thickness：100μm、200μm

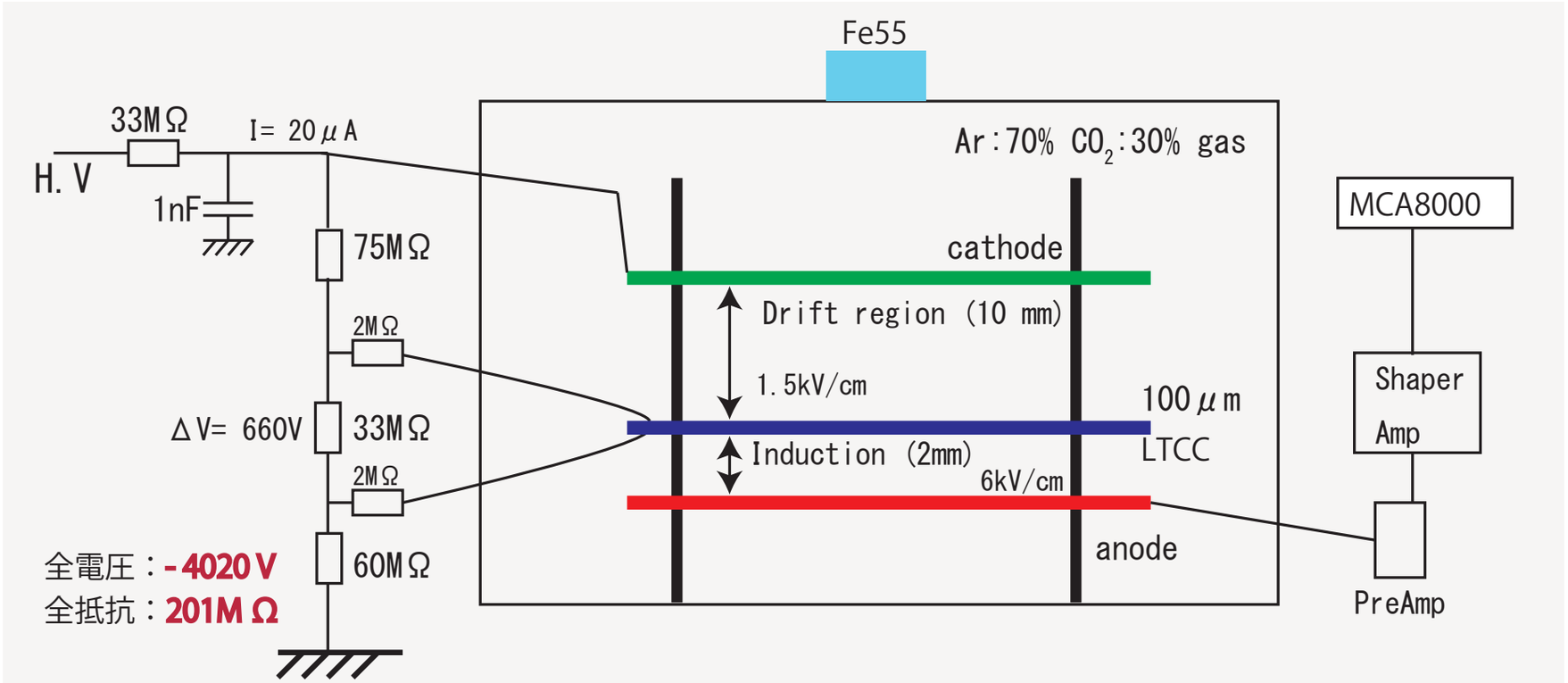


LTCC-GEM（white:LTCC、electrode:Au）



Micro scope picture

Gain measurement



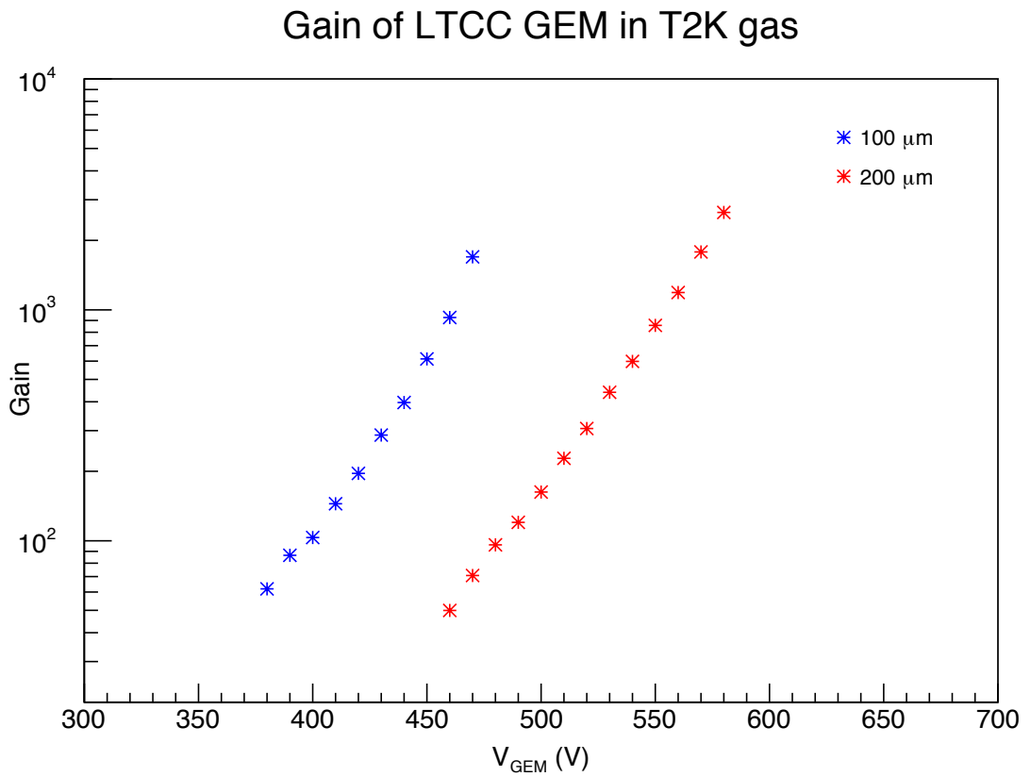
Using 100μm and 200μm

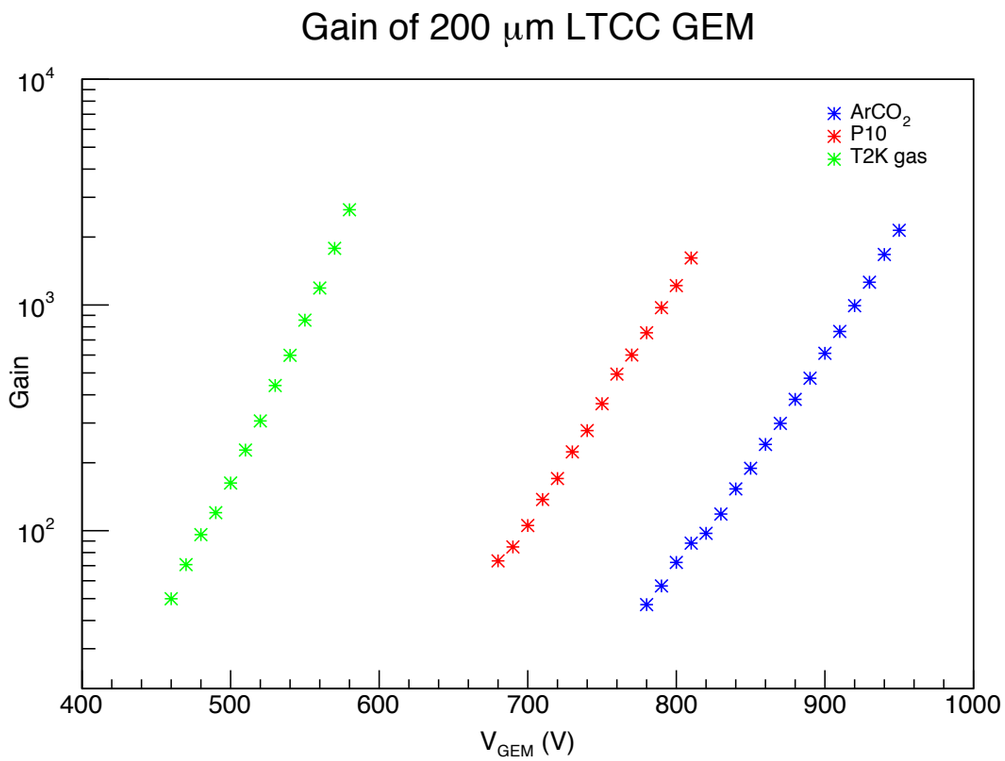
Readout pad size 10cm X 10cm

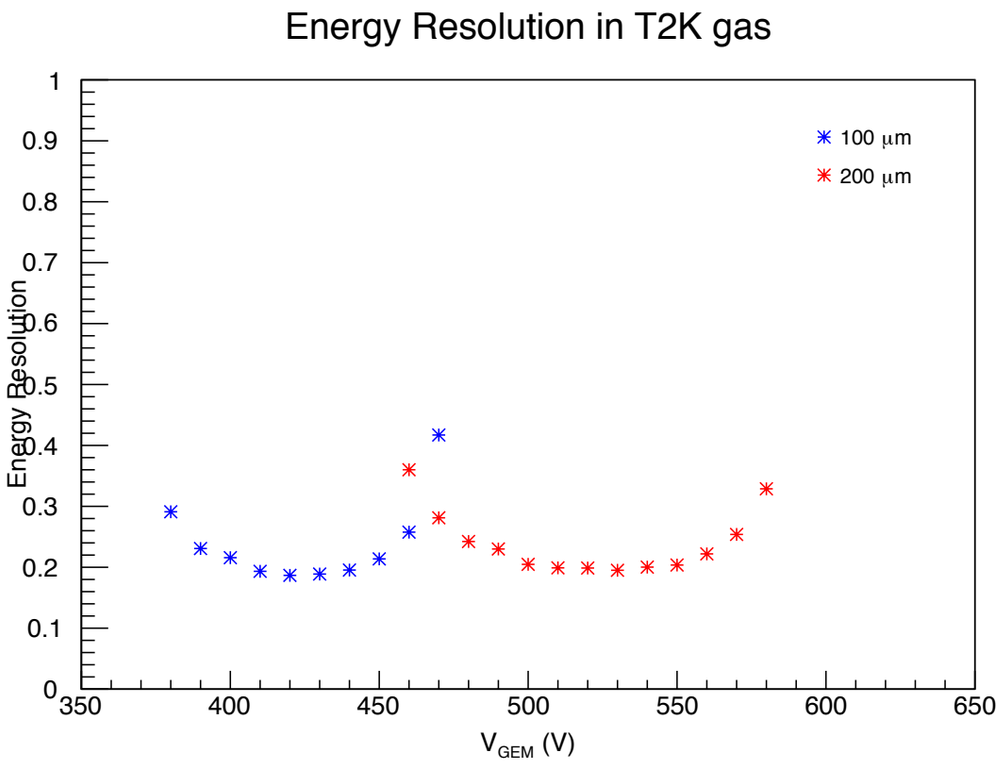
Voltage setting on Drift and Induction regions

Gas	ArCO2 (Ar:70%, CO_2:30%)	P10 (Ar:90%, CH_4:10%)	T2K (Ar:95%, CF_4:3%, iC_4H_{10}:2%)
Drift region	1.5 kV/cm	0.75 kV/cm	0.23 kV/cm
Induction region	6.0 kV/cm	3.0 kV/cm	2.7 kV/cm

Gain measurement







- **Gain is achieved around 2000**
- **Energy resolution is 20%〜40%**

Gain by Komiya san's (TIRI) measurement can be reached over 10000 (100μm)

-> I don't know why my result is lower than Komiya san's result.