Highlights of the MPGD Japanese workshop (MPGD2017)

S. Narita (Iwate University)

RD51 mini week

14-Dec-2017

Japanese MPGD workshop series

Topics :

- Basic study, characterization
- Readout electronics, systems
- Application for HEP, astrophysics, and general purpose

MPGD2017 --- 14th workshop

December 1-2, 2017

Iwate University

2004 Kyoto U.
2005 Osaka U. –RCNP
2006 Saga U.
2007 Osaka City U.
2008 Riken
2009 Kobe U.
2010 Yamagata U.
2011 Kinki U.
2012 NiAS
2013 Kyoto U.
2014 Tohoku U.
2015 Hiroshima U.
2016 Kobe U.

~50 participants

21 scientific talks in MPGD2017

Base technology

- μ-PIC, Micromegas, GEM, Capillary plate
- TPC

Applications

- Neutron imaging
- X-ray/γ-ray imaging for astrophysics
- Tracking, calorimeter for HEP
- Dosimeter

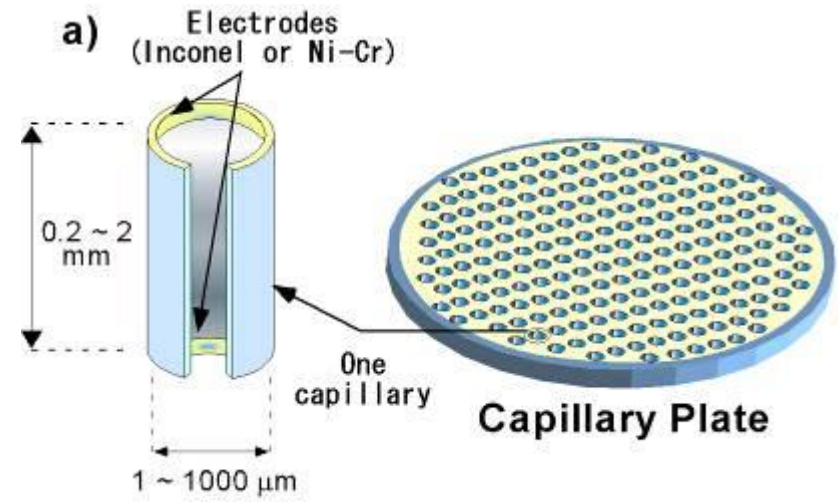
Basic study

- New materials
- Machining
- Medium gas for particle detection

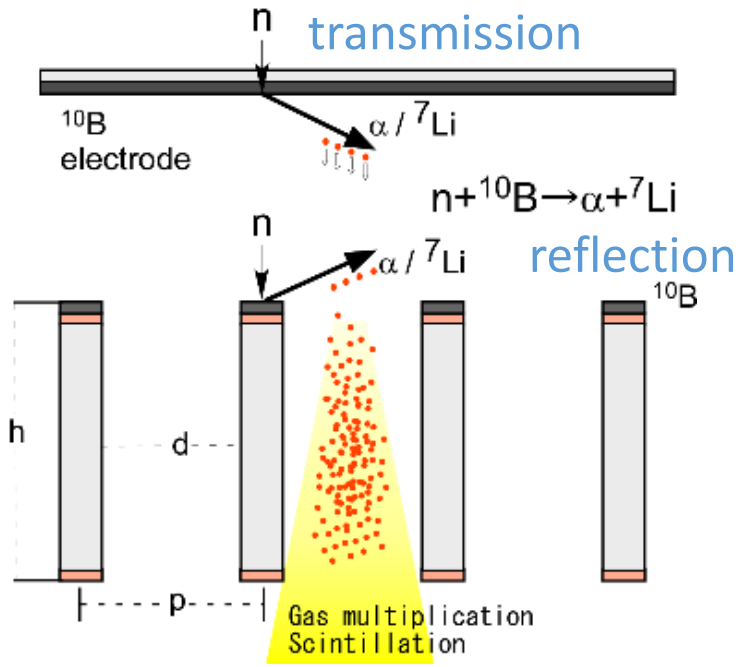
Some talks covers multiple topics

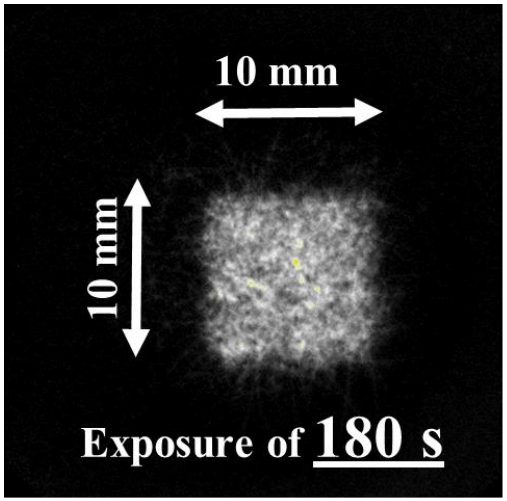
Neutron imaging with glass capillary plate

R.Ito (Yamagata U)



Material	Glass capillary
Outer Diameter (mm)	10~100
Package Density (cm^{-2})	~10^6
Thickness (mm)	0.2~2
Channel Diameter (μm)	1~1000
Open area ratio(%)	60 (80)
Electrode Material	Inconel or Ni-Cr





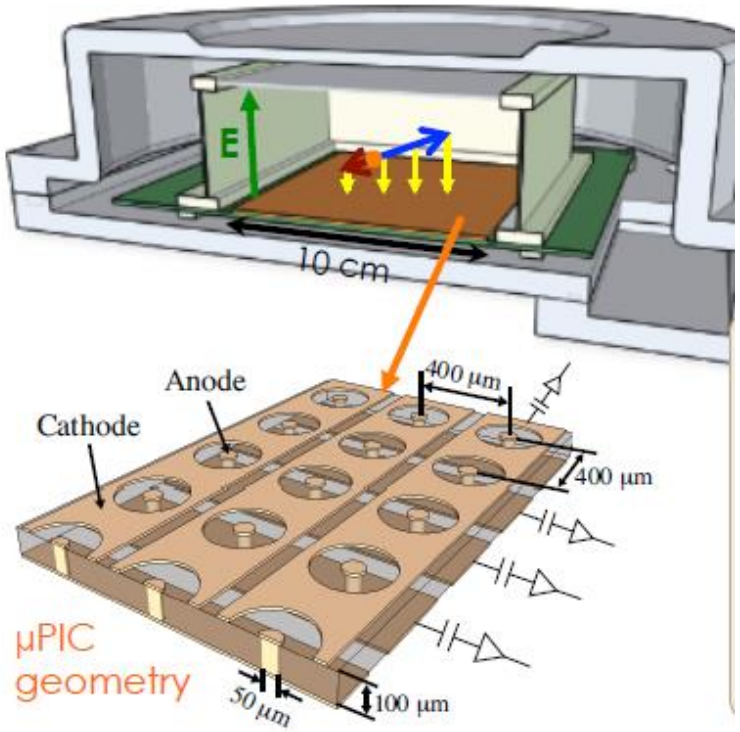
Gas scintillation imager

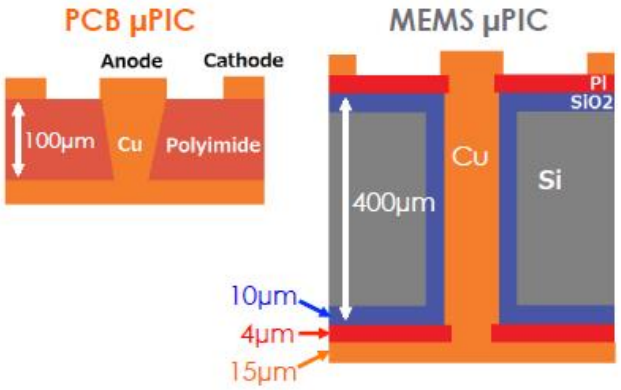
Efficiency: ~4.2 %

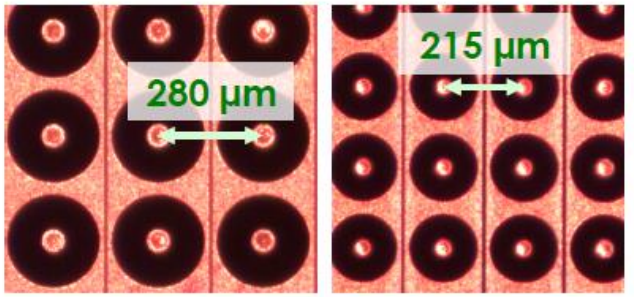
Position resolution: ~ 1 mm

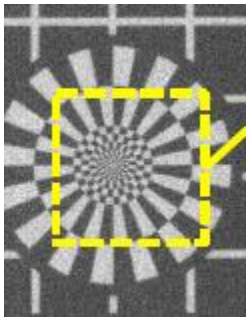
μ-PIC based neutron imaging detector

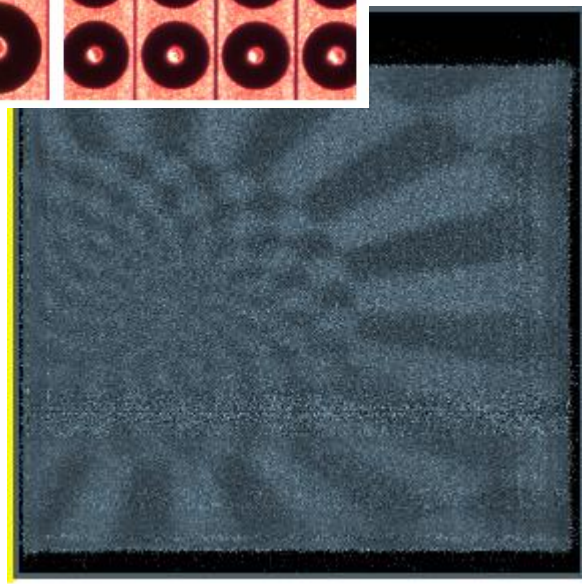
J.Parker (CROSS)











Improve position resolution
-> reduce the pitch of μ-PIC
400 um -> 215 um

Gain stabilization is also considered

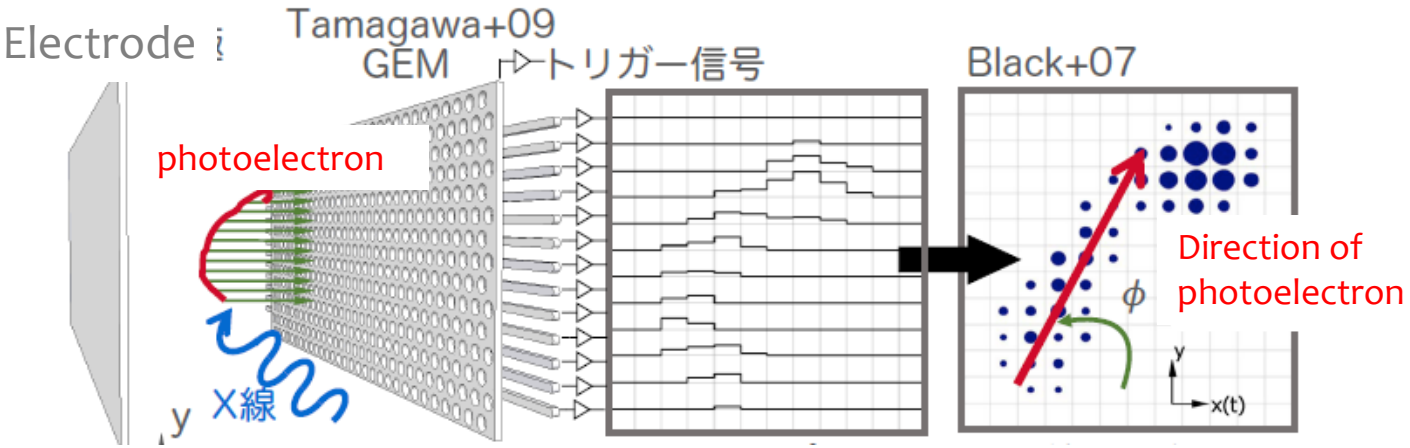
GEM based x-ray polarimeter

M.Okubo (TUS/RIKEN)

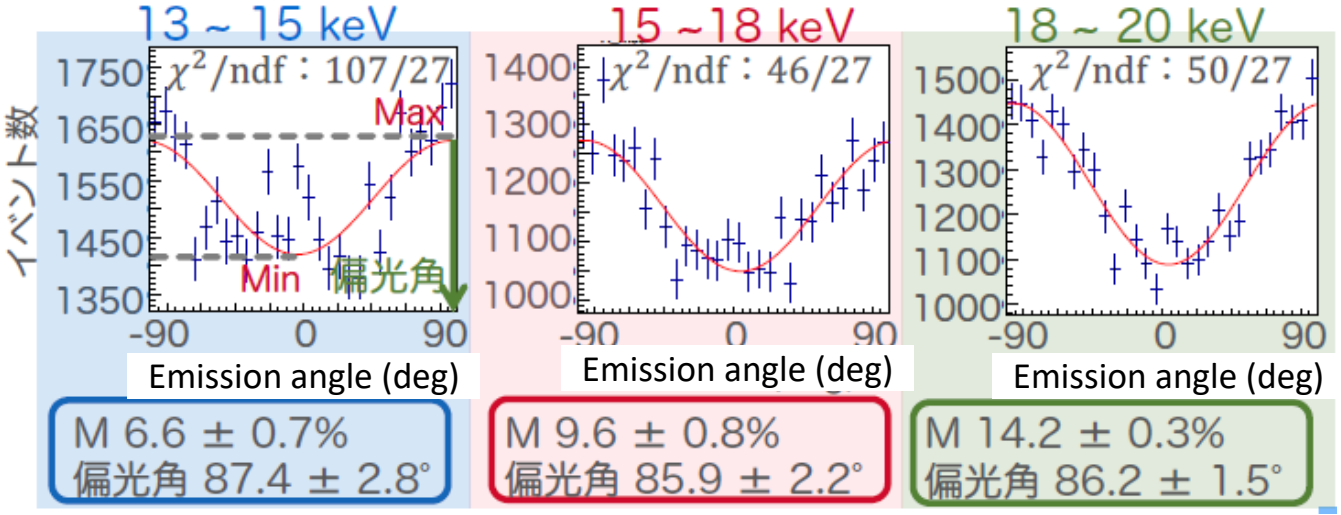
Interesting for observing high energy X-rays

E < 8keV : IXPE satellite

E > 8 keV : TPC type polarimeter <- supposed to have high polarization



Track direction of the photoelectron depends on the X-ray polarization

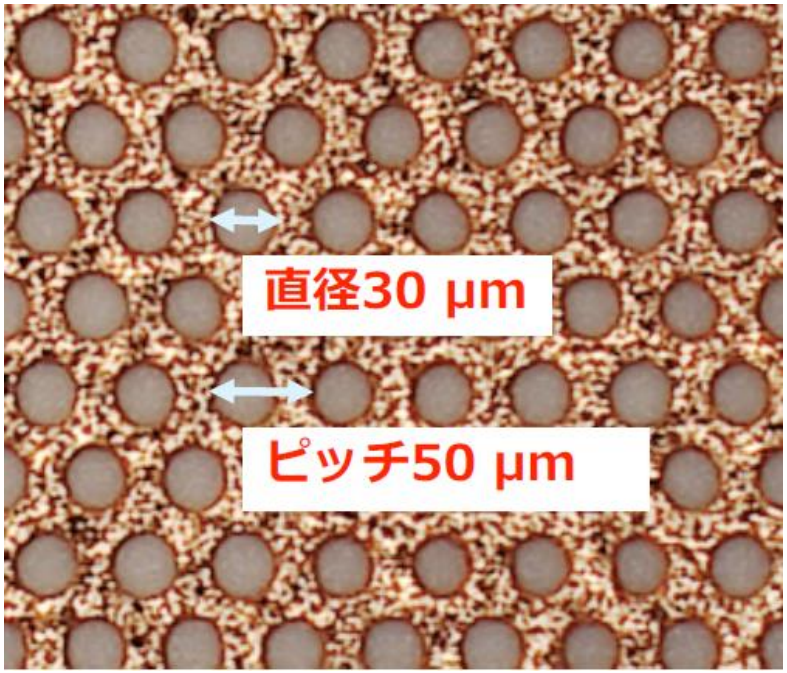


For non-polarized X-ray
M=0.3±0.3%

GEM for IXPE

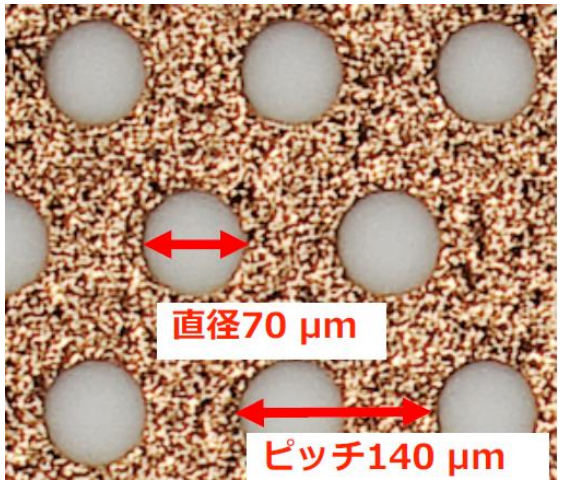
Y. Zhou (TUS/RIKEN)

(Imaging X-ray Polarimetry Explorer)

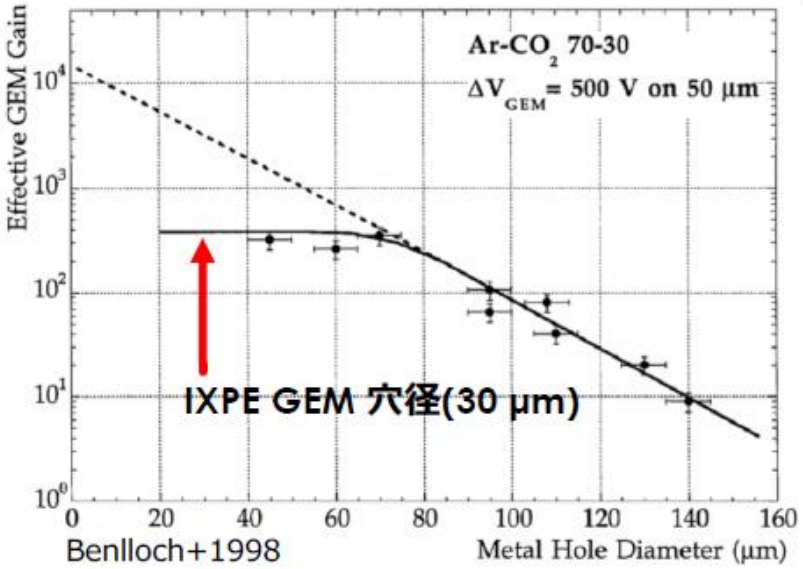


IXPE GEM (15mm x 15 mm)
-> need to inspect hole shape
-> established to pattern recognition tool

Measured gain map
-> found no affection of hole size variation to the gain.



GEM for TPC polarimeter
(30 mm x 78 mm)



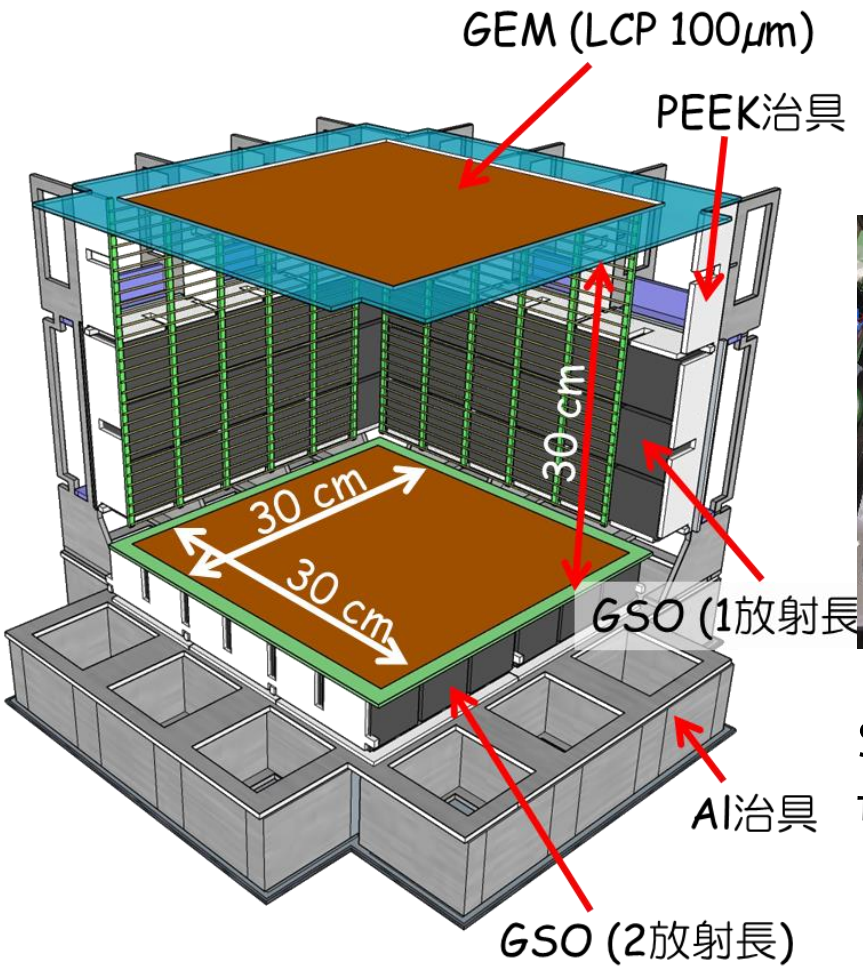
MeV gamma-ray telescope (SMILE-2+)

A. Takada (Kyoto U)

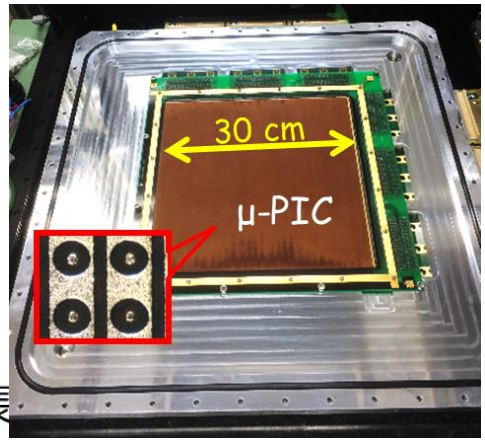
Sub-MeV gamma-ray Imaging Loaded-on-balloon Experiment

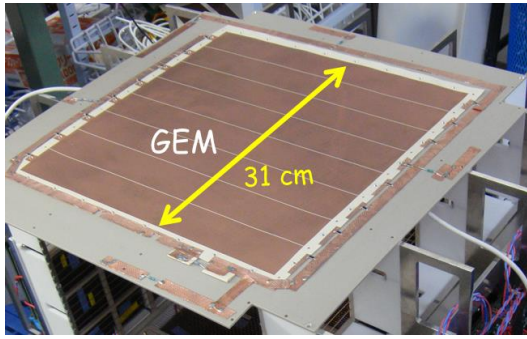
Wide energy band keV ~ 100 MeV
Wide viewing (omnidirectional)
High S/N

Electron Tracking Compton Camera



- GSO + PMT
- Implemented gas purification system ensure the long-term stability



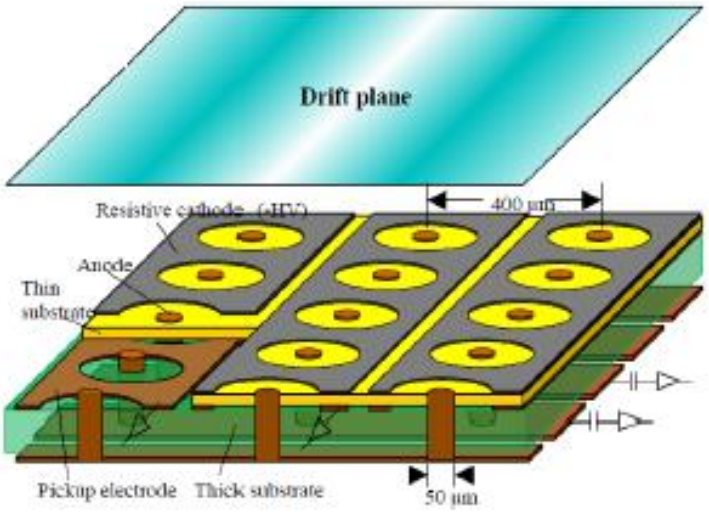


Successfully obtained the image for gamma from the source.

Experiment period : Apr. 1 – May 6, 2018

μ-PIC with high resistive cathode

F.Yamane, Y.Ishitobi (Kobe U)

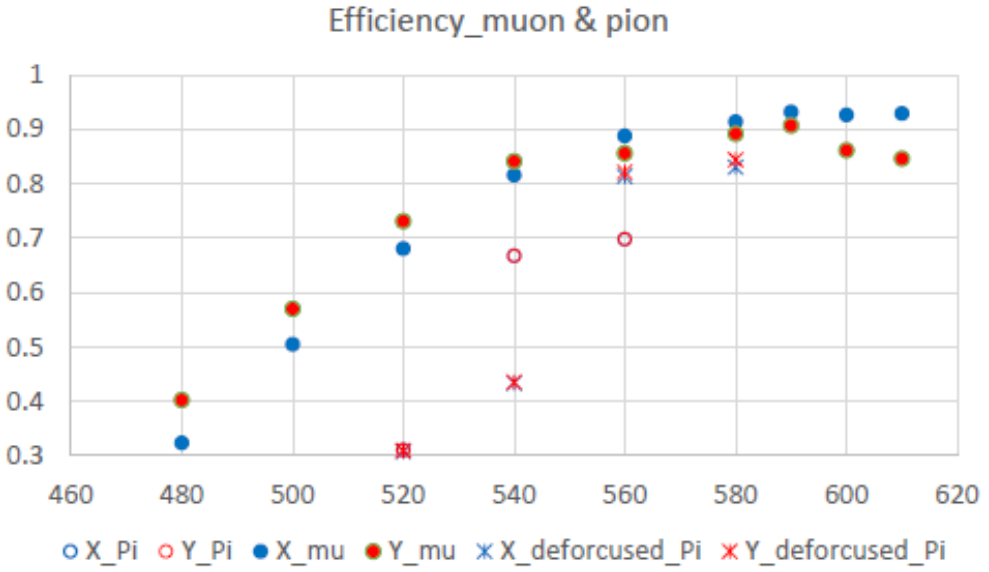


- Resistive cathode (carbon polyimide $10^{5\sim7}$ Ω/sq)
  -> reduce discharge
- Expect high rate capability

Test with 150GeV μ/π beam

- Efficiency
  Anode: ~94%
  Cathode: < 90%
  (decrease @ high gain)
- Position resolution:
  < 80 um for the cathode direction

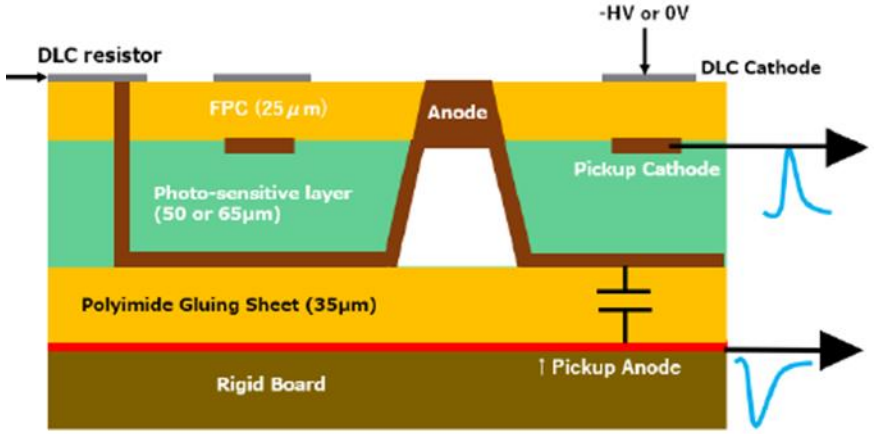
Preliminary



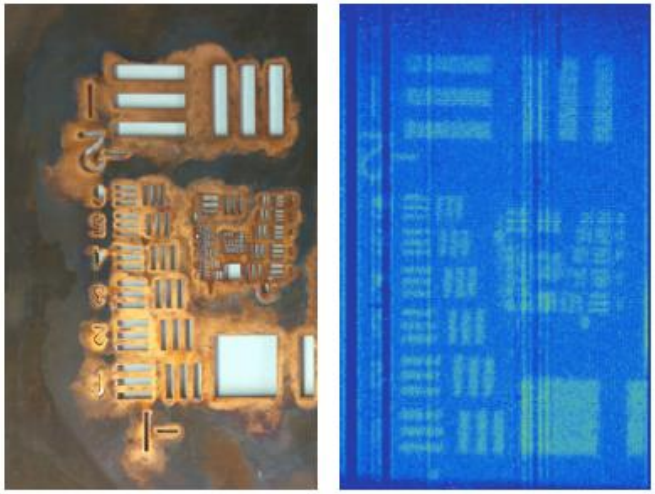
DLC electrode

- DLC deposition by sputtering
- The resistivity of the layer can be controlled by changing the thickness
- Can make fine-pattering

-> expected to be used for high signal rate experiment



X-ray imaging test Cu Kα (8 keV)



- Position resolution
  anode: ~ 190 um, cathode: ~160 um
  (still considering the misalignment, …)
- Rate capability
  work stably up to 13 MHz/cm^2

Aging test of Micromegas for γ-ray irradiation

K.Matayoshi (Kobe U)

For HL-LHC

expected BG on MM of endcap muon detector

n: 0.1 kHz/cm², γ: 1.5 kHz/cm²

In the past experiment

HL-LHC 10 yr … 2MΩ/sq -> 5MΩ/sq

no significant degradation in the gain

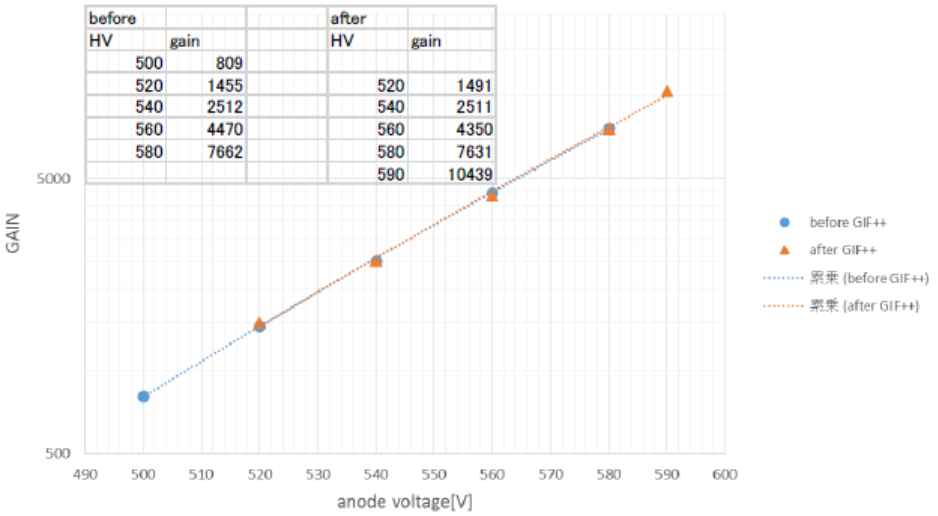
HL-LHC 80 yr … the surface resistivity increased to a few 10 times

~20 % down in gain

← Si composite material might affect

Tested Si-free (Si-reduced) detector (Dose: HL-LHC 42 yr = 117 mC/cm²)

before		after	
HV	gain	HV	gain
500	809		
520	1455	520	1491
540	2512	540	2511
560	4470	560	4350
580	7662	580	7631
		590	10439

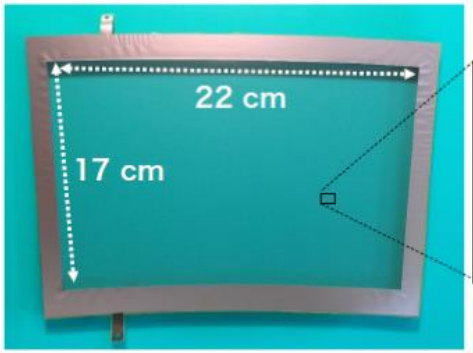


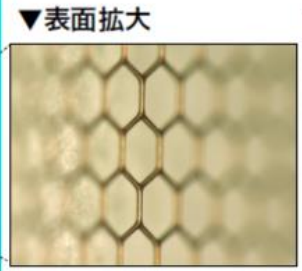
- No significant change in the gain and resistivity
- Efficiency: ~94%
  lower than requirement
  investigating the reason

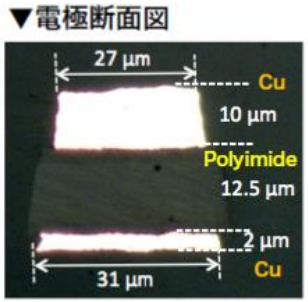
GEM type gating device

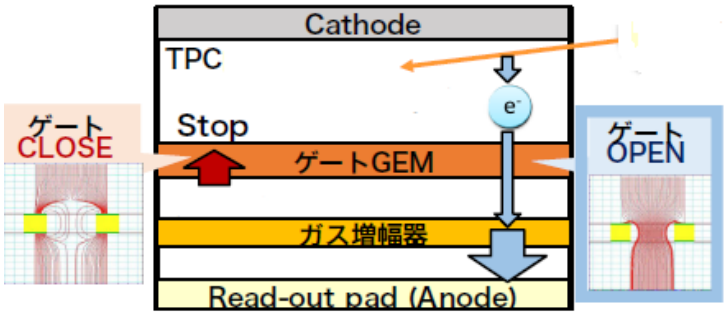
A.Shoji (Iwate U)

For developing ILD-TPC



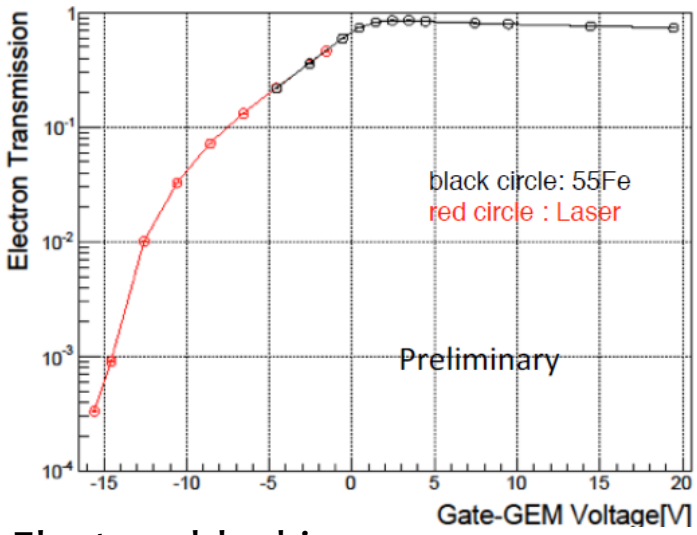




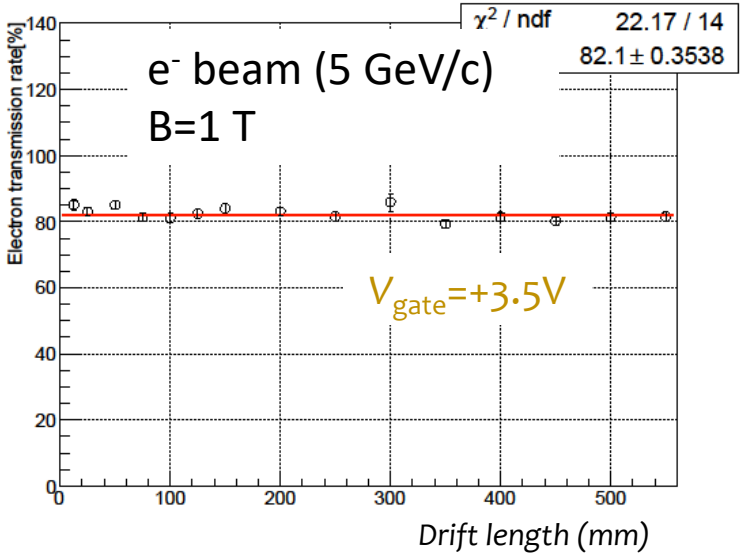


Hole size	304 μm
Hole pitch	335 μm
Rim width : F-side	27 μm
Rim width : B-side	31 um
Insulator thickness	12.5 μm
Optical aperture ratio	82.3 %

Electron transmission rate



Electron blocking power
> ~ 99.97% @ΔV=-15.5 V
(expect much larger blocking power for ion)



Electron transmission rate ~ 82%

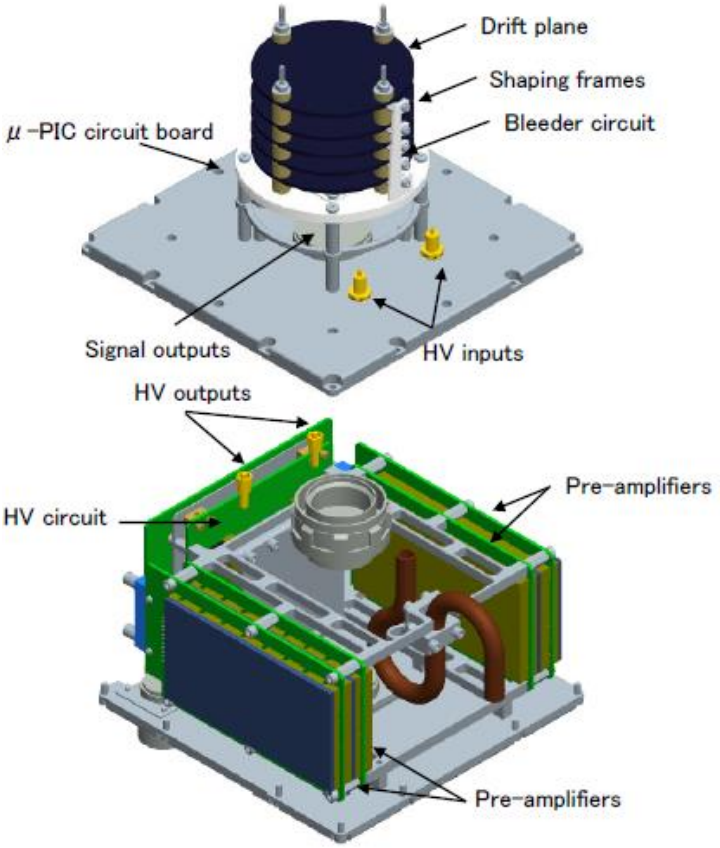
Demonstration of the PS-TEPC performance

Y.Kishimoto (KEK)

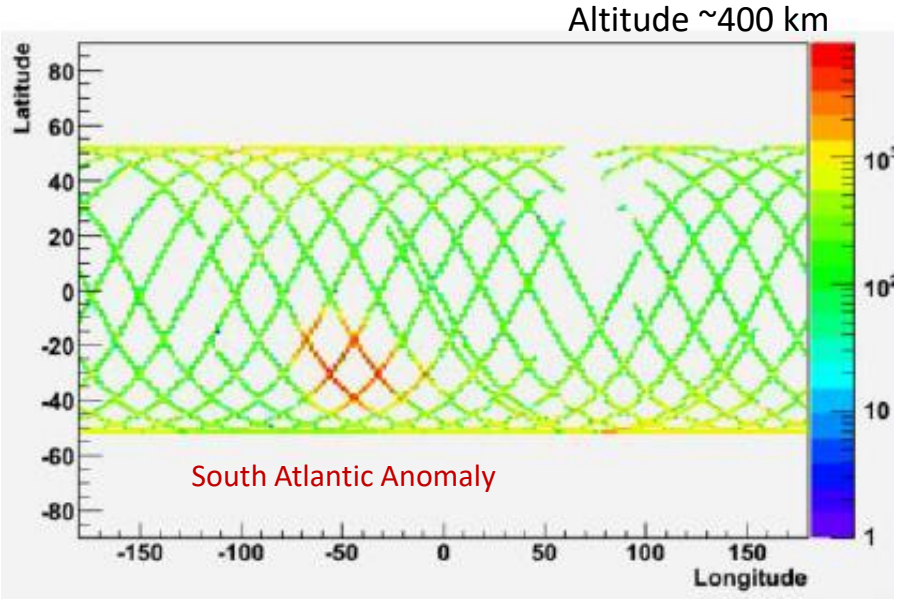
Position Sensitive Tissue Equivalent Proportional Chamber

Measure radiation doses and path length of space radiation particles, and determine the real time LET to asses the radiation risks to crew.

Fiducial volume: 2.6 x 2.6 x 5.0 cm^3
μ-PIC: 400 um pitch
Strips Anode 64, Cathode 64



Launched: 9th Dec. 2016
Installed on ISS: 14 Dec. 2016
Started operation: 28th Dec. 2016



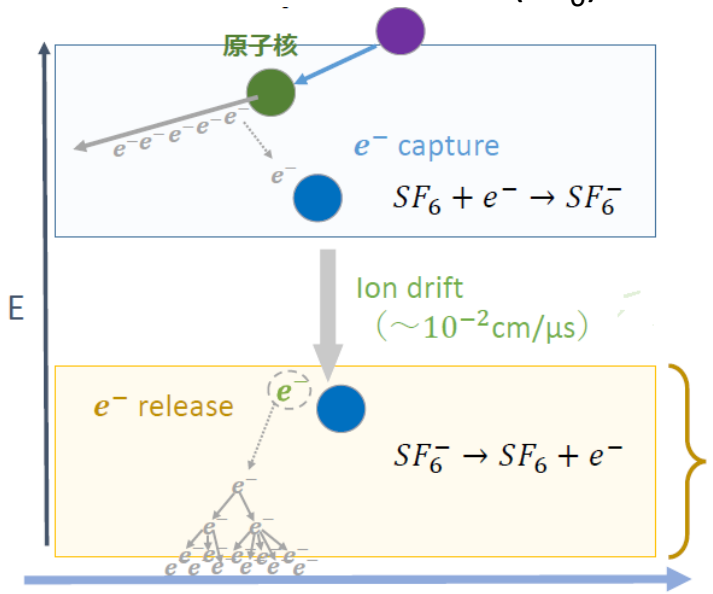
Observed fluctuation of the count rate at polar and SAA regions
<- due to variation of Cosmic Ray flux

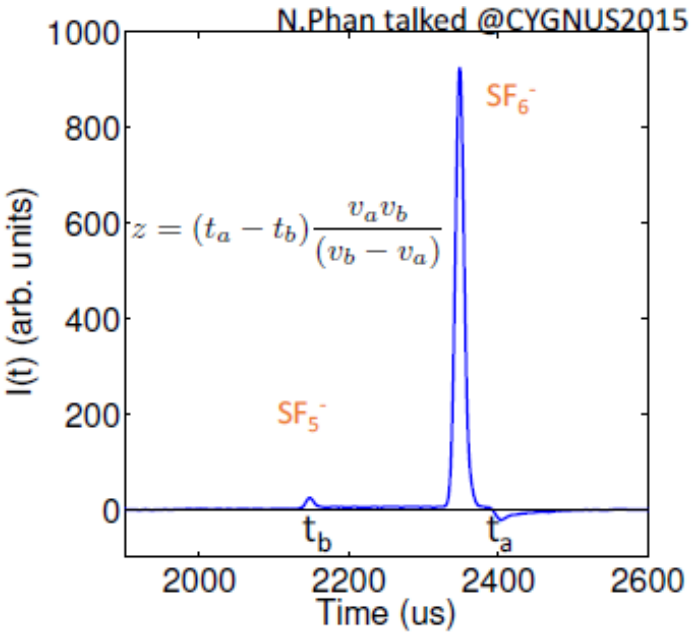
Negative-ion TPC with μ-PIC

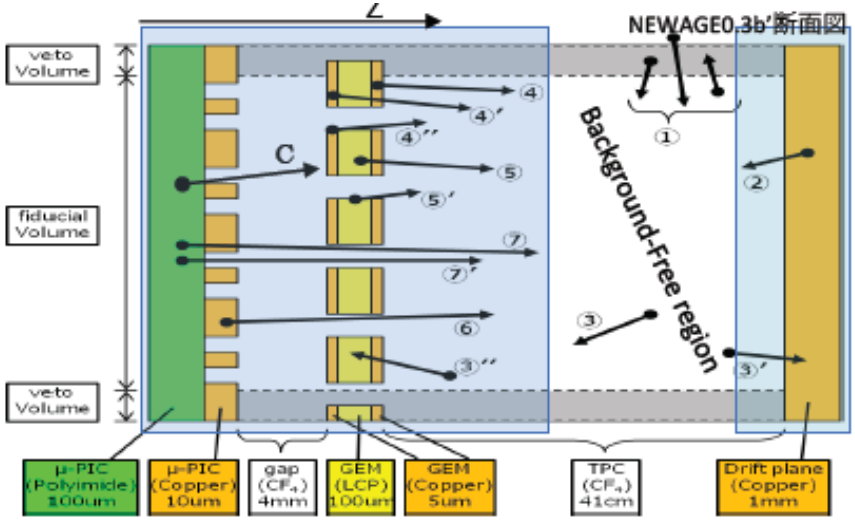
H.Ishiura, T.Ikeda (Kobe U)

Directional Dark Matter search

sulfur hexafluoride (SF_6)





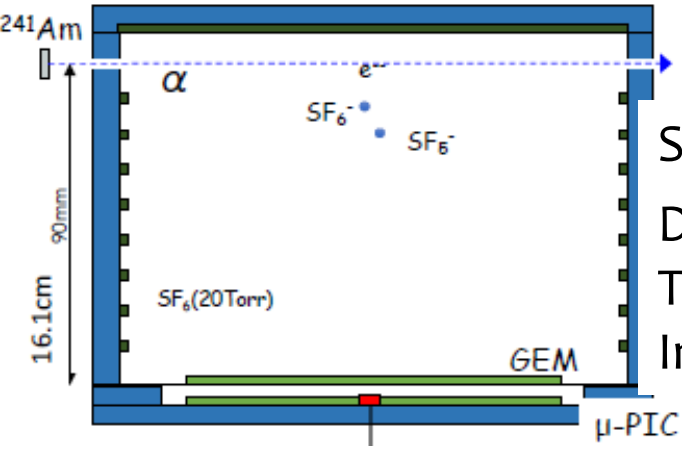


Can determine absolute z position of track

-> allow to make fiducial volume cut in z

-> can remove α-ray BG from GEM/μ-PIC material.

- Gain measurement for SF_6 gas with Triple GEM system

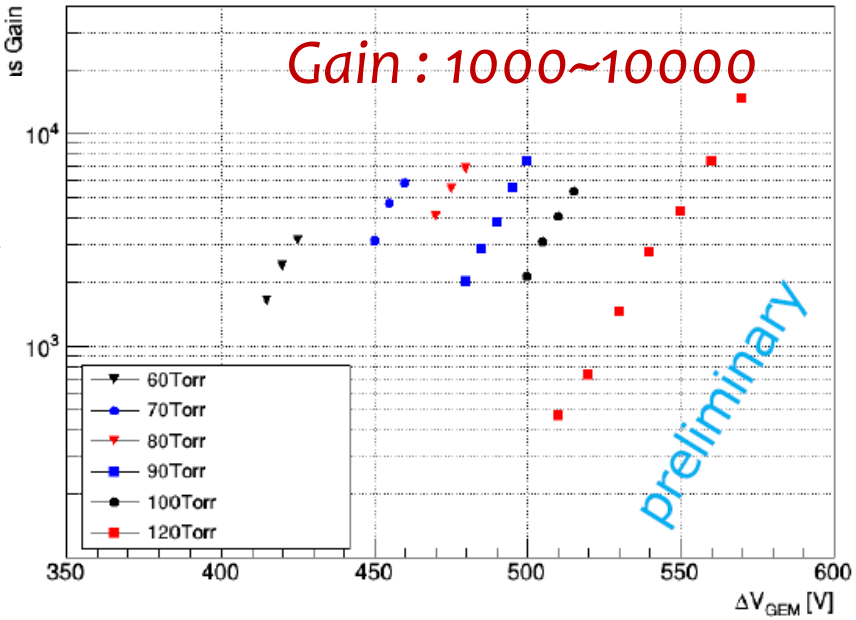


SF_6 : 60~120Torr

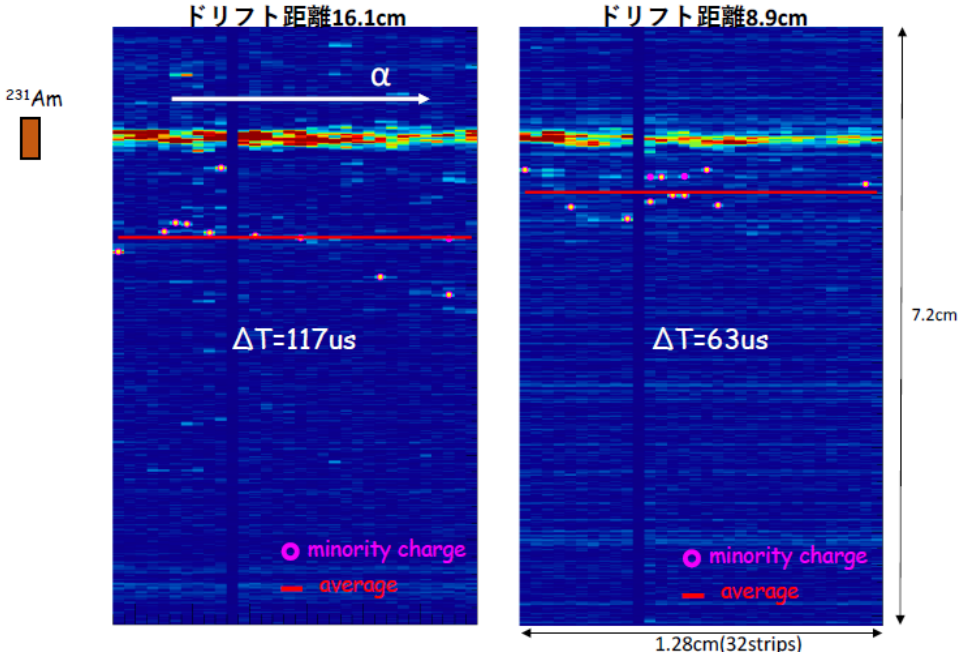
Drift: 1 kV/cm

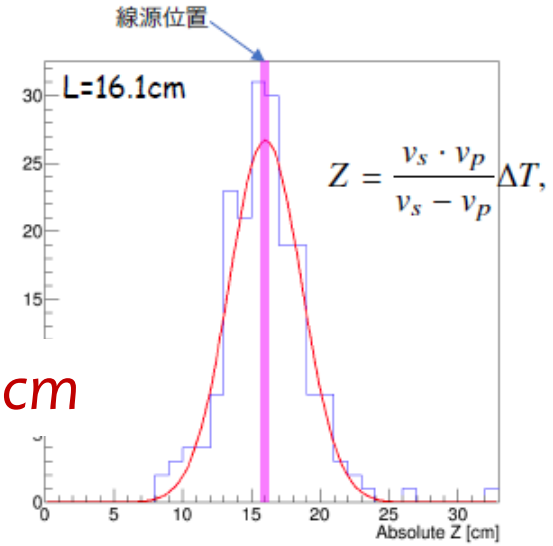
Transfer: 2.86 kV

Induction: 2.5 kV



- Z position determination

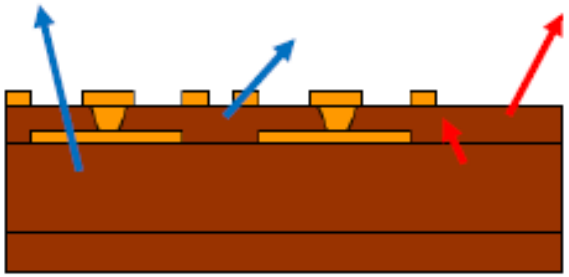




$\sigma_z \sim 2.6$ cm

Low BG μ-PIC

K.Miuchi (Kobe U)

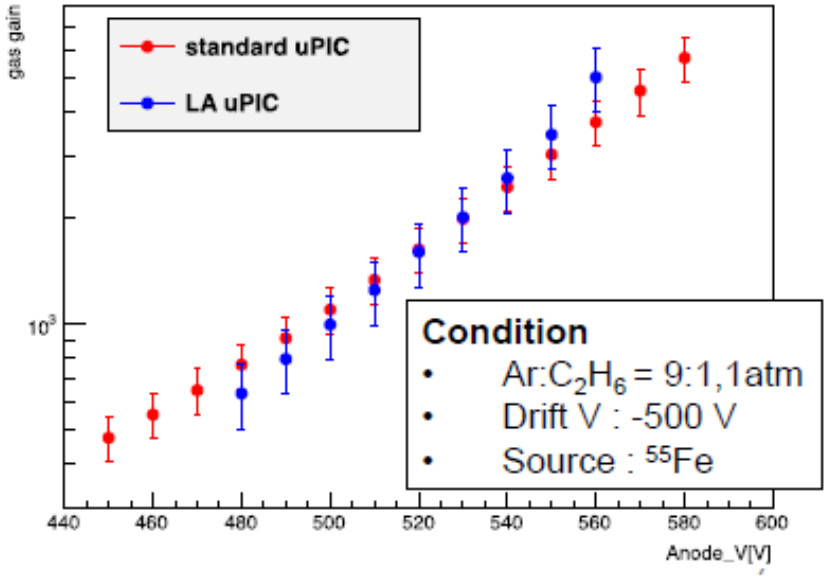


α-ray (most surface layer)
γ-ray, neutron (substrate)

Modify the material and structure of surface layer
-> low α μ-PIC

TABLE 3. ^{238}U and ^{232}Th measurement results using the HPGe detector. The uncertainties listed are statistical errors.

Sample	^{238}Uupper stream [10^{-6} g/g]	^{238}Umiddle stream [10^{-6} g/g]	^{232}Th [10^{-6} g/g]	Note
PI100 μm insulator	0.38 ± 0.01	0.39 ± 0.01	1.81 ± 0.04	Current material
PI(75 μm)+epoxy(5 μm)	$< 2.86 \times 10^{-2}$	$< 2.98 \times 10^{-3}$	$< 6.77 \times 10^{-3}$	New material

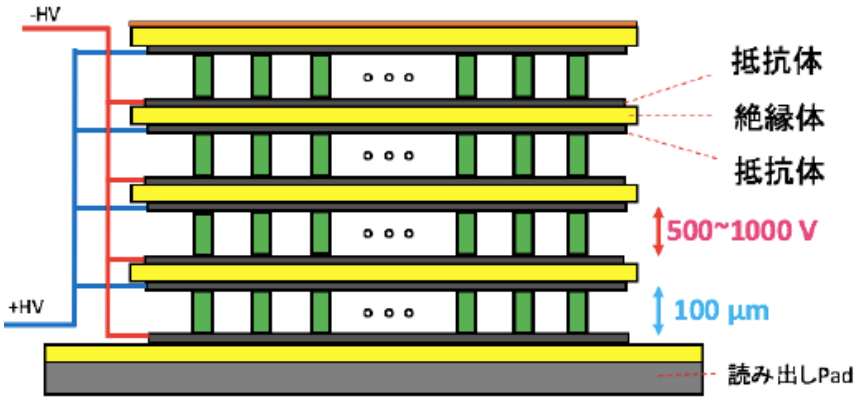


They also tried to modify the material of core (middle) layer

Freon-base RPC

K.Ogawa (Kobe U)

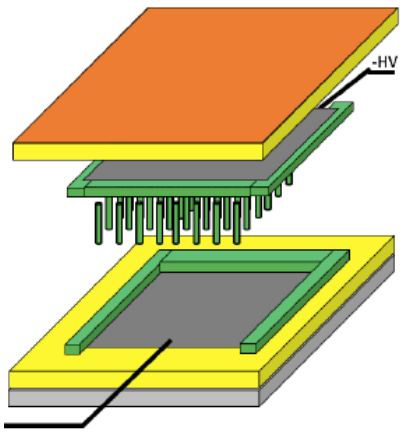
Realize thin gap RPC with time resolution < 10 ps

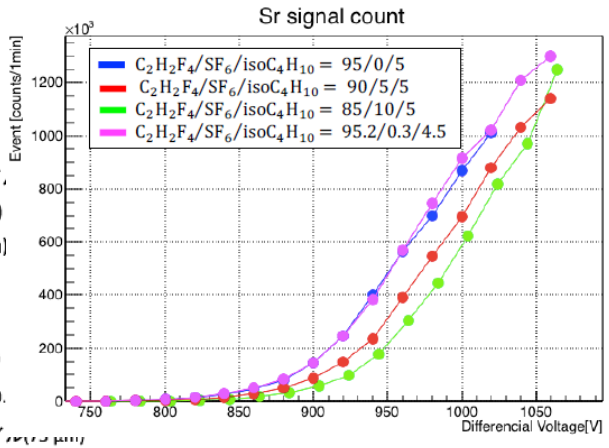


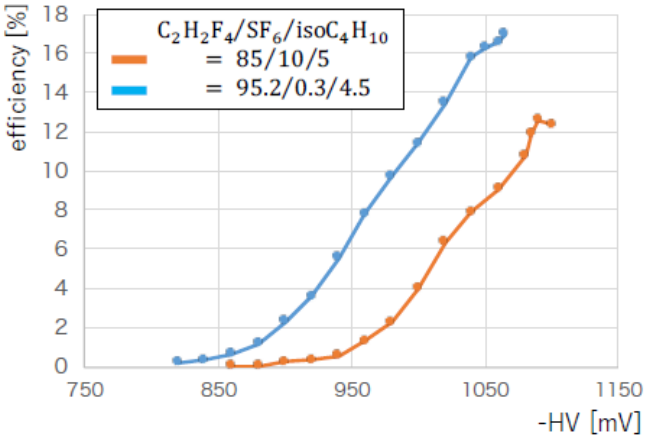
DLC membrane is deposited by Ar+ beam sputtering
(the resistivity can be controlled by the thickness)

To be considered
- surface flatness
- efficiency

Tested single-RPC







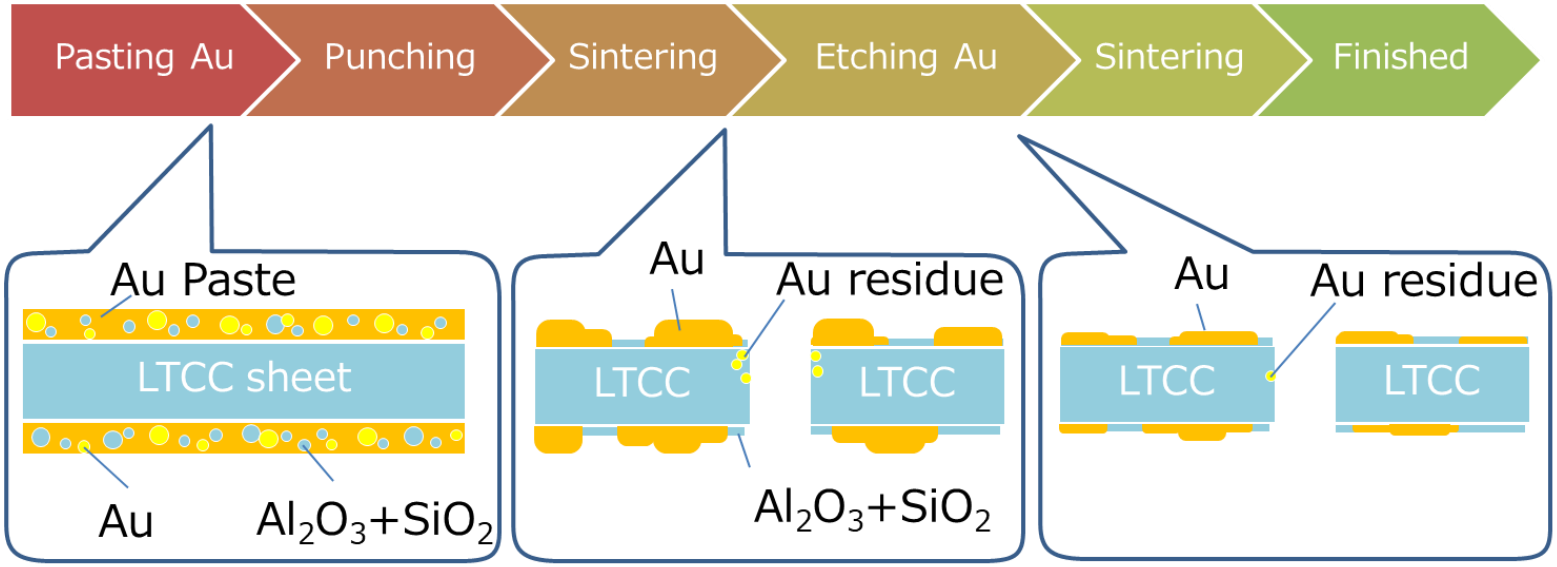
Efficiency: ~10%
Time resolution: a few 10 ns

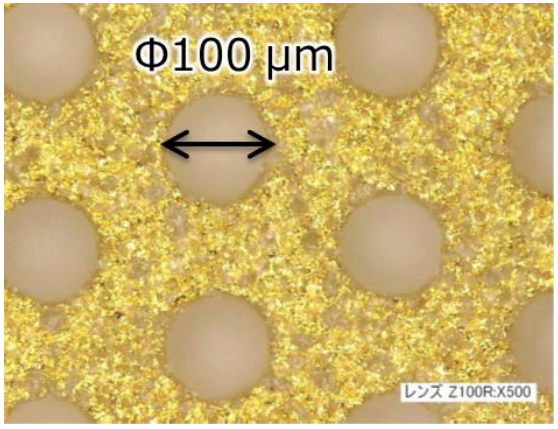
very preliminary

Low Temperature Co-fired Ceramic (LTCC) GEM

Hirai Seimitsu Kogyo Corporation

K.Komiya, Y.Takeuchi (TIRI)
Y.Kato (Kinki U)





Optimizing the process
- *> longer etching time*
- *> adding Au plating process after re-sintering*

Gain : ~8000 @ ΔV~750 V

Discharge rate : > 10 counts/min @ ΔV>700V
but not brokendown

The presentation files are on the workshop website.

https://kds.kek.jp/indico/event/25061/