

# Development of 6-gap Bakelite Multigap Resistive Plate Chamber

**Rajesh Ganai\***

**On behalf of**

**Mitali Mondal, Shaifali Meheta,  
Zubayer Ahammed  
and Subhasis Chattopadhyay**

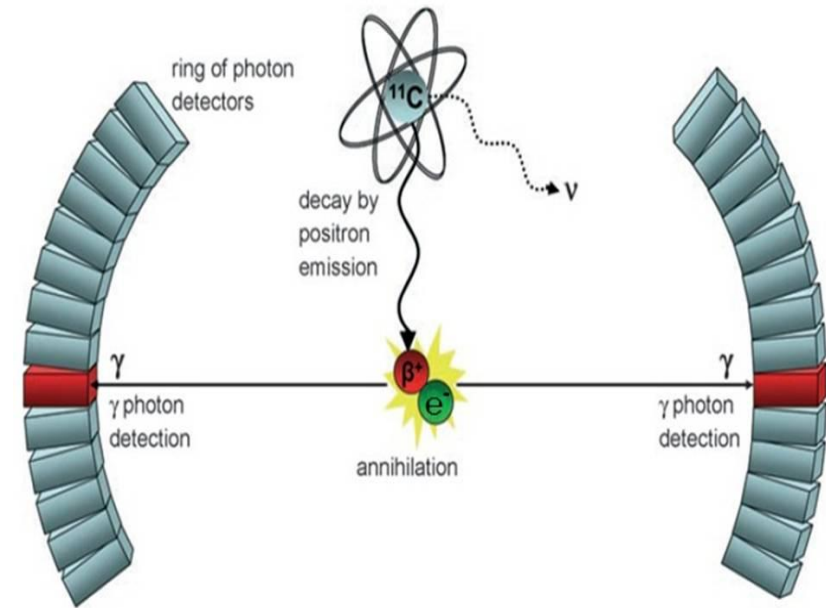
## Outline

- **Motivation**
- **Multi-Gap Resistive Plate Chamber (MRPC)**
- **Electrical properties of the Bakelite samples**
- **Development of a six gap Bakelite MRPC**
- **Characterisation of the developed MRPC**
- **Summary and Outlook**

\* [rajesh.ganai.physics@gmail.com](mailto:rajesh.ganai.physics@gmail.com)

*Thank you, the organisers of ADNHEAP*

# Time of Flight Positron Emission Tomography (ToF-PET)



Positron Emission Tomography (PET) is a nuclear medicinal imaging technique that is used to observe metabolic processes in the body by the basic principle of detecting a pair of back to back photons created by the annihilation of  $e^+$  and  $e^-$ .

The drug used is **Fluorodeoxyglucose (FDG)** (common name).

IUPAC name : **2-Deoxy-2- $^{18}\text{F}$ fluoroglucose**

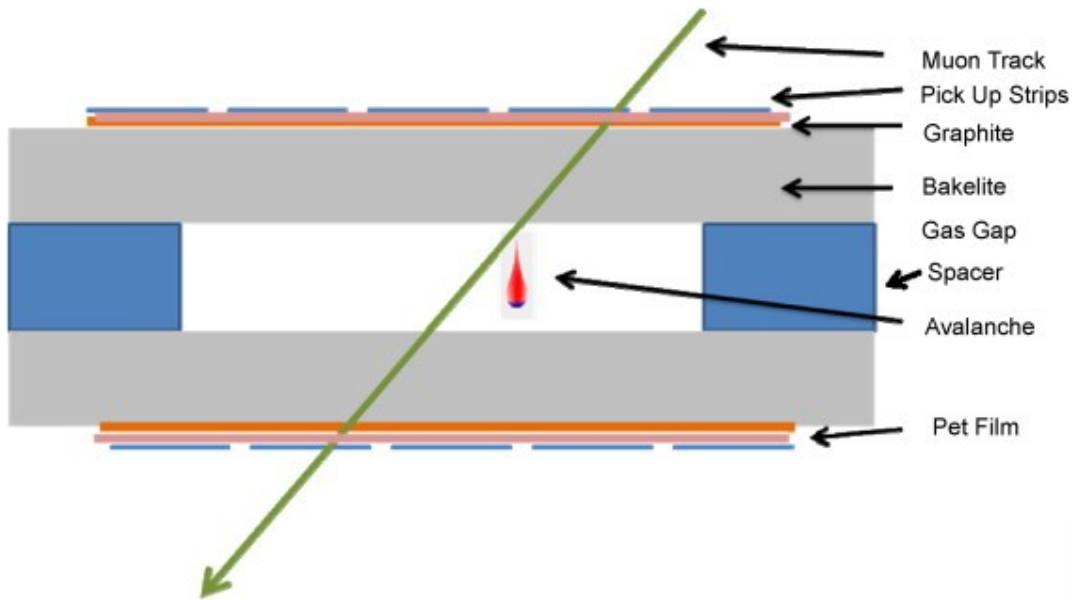
We have developed two nearly identical 5-gap glass MRPCs to establish the basic working principle of PET imaging. (presented in DAE BRNS HEP 2016 symposium)

## Why MRPCs ?

1. They are low cost and easy to fabricate.
2. They have good time resolution ( $\sim 10$  ps). (Of course it depends on the number of gas gaps.)
3. They can easily be fabricated over a large area.

Main disadvantage is that they have very poor photon detection efficiency.

# Multi-gap Resistive Plate Chamber

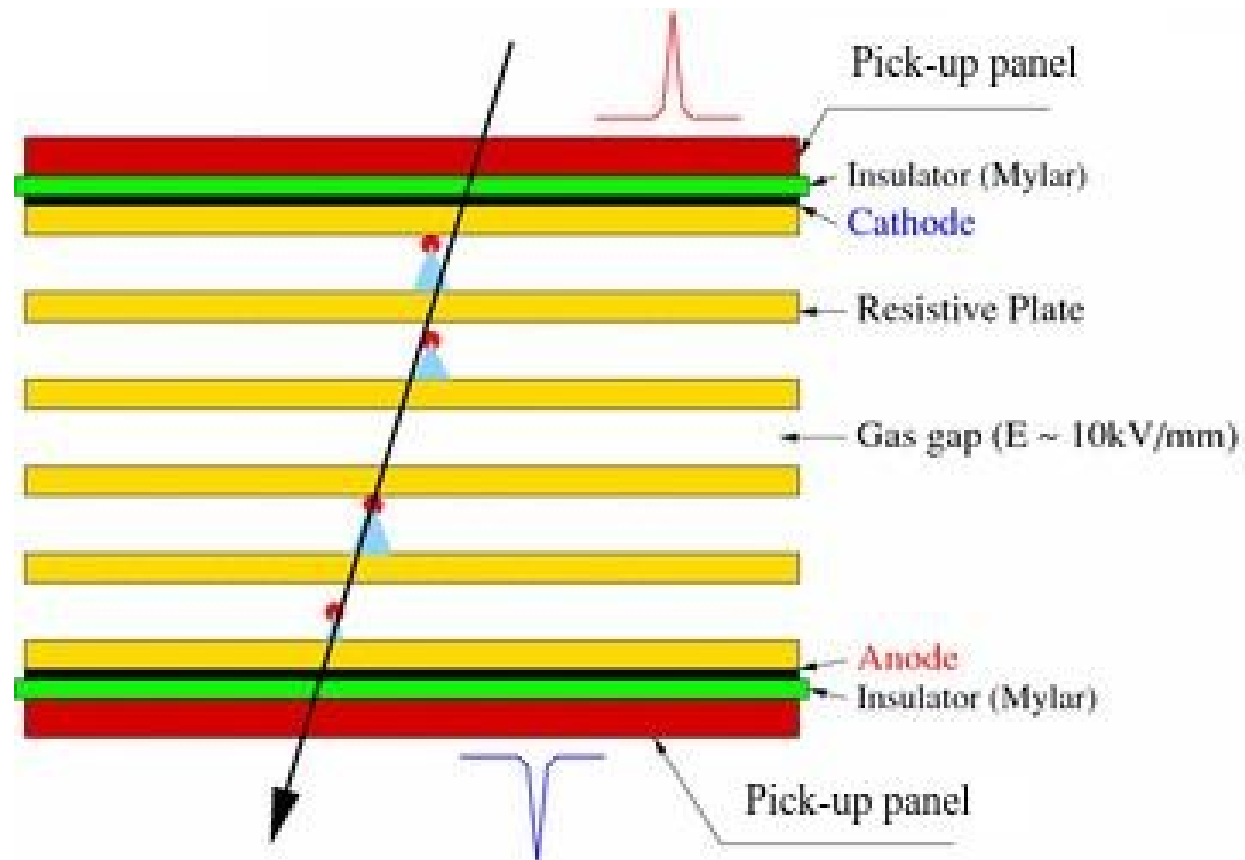


Detection efficiency : > 95 %

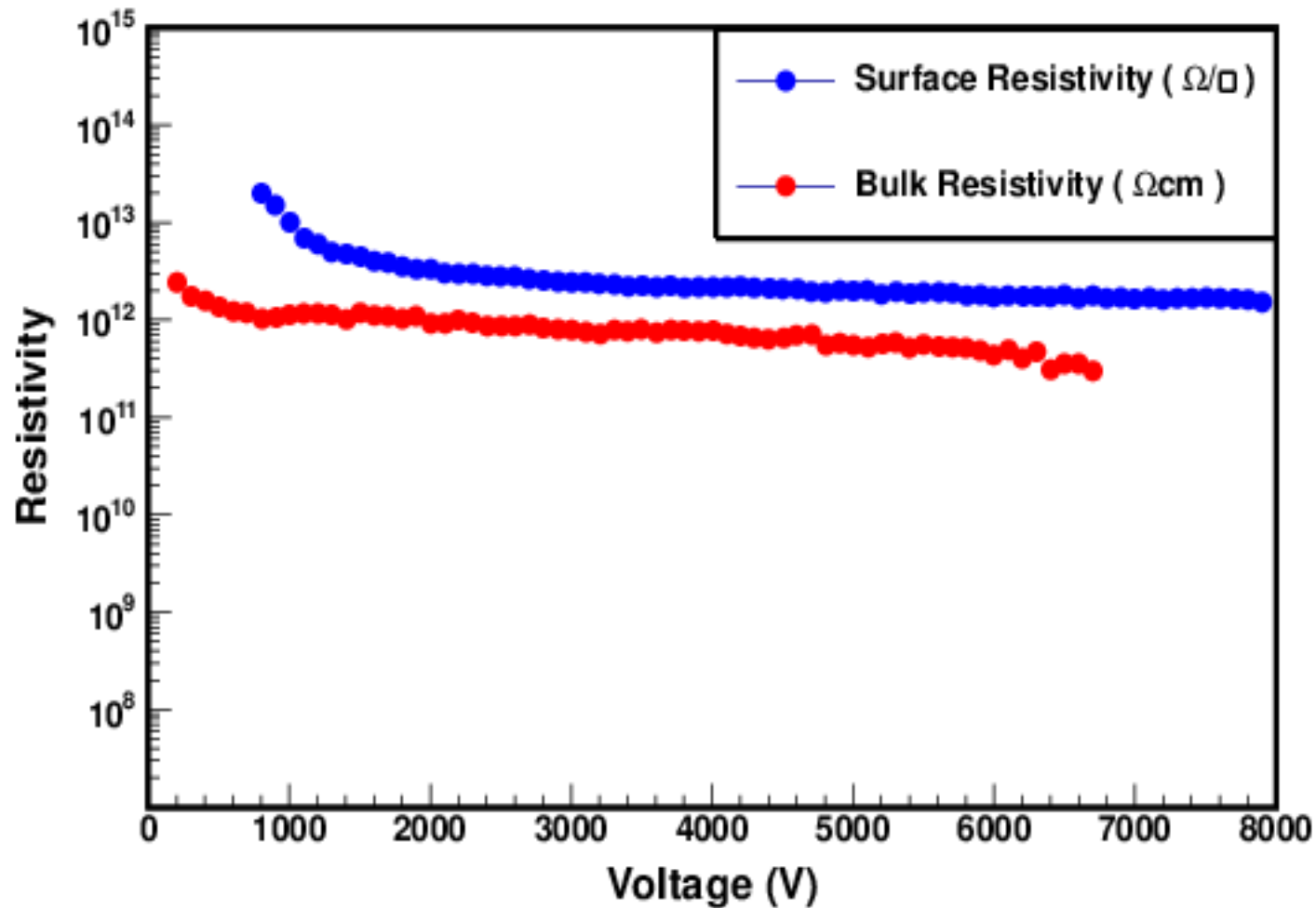
Time resolution : ~ 1 ns

Detection efficiency : > 95 %

Time resolution : ~ 10's ps  
(depends on number of gaps)



# Electrical Properties of the Bakelite Sample



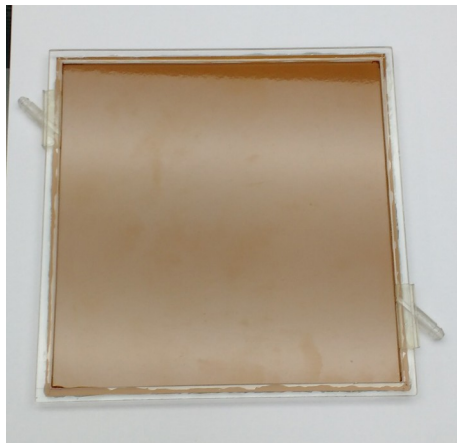
The average bulk resistivity  $\sim 9 \times 10^{11} \Omega \text{ cm}$

The average surface resistivity  $\sim 3 \times 10^{12} \Omega / \blacksquare$

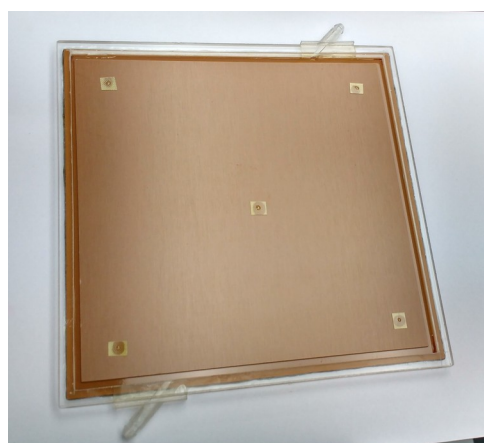
# Development of Bakelite MRPC



(a)



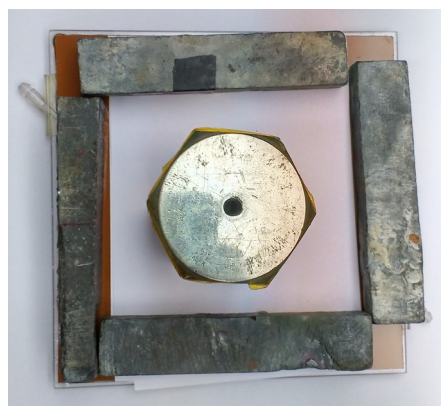
(b)



(c)



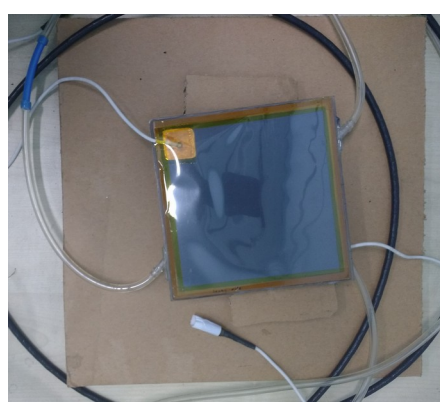
(d)



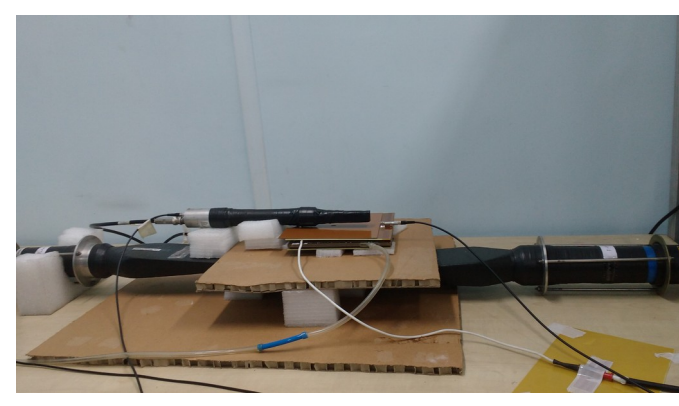
(e)



(f)



(g)



(h)

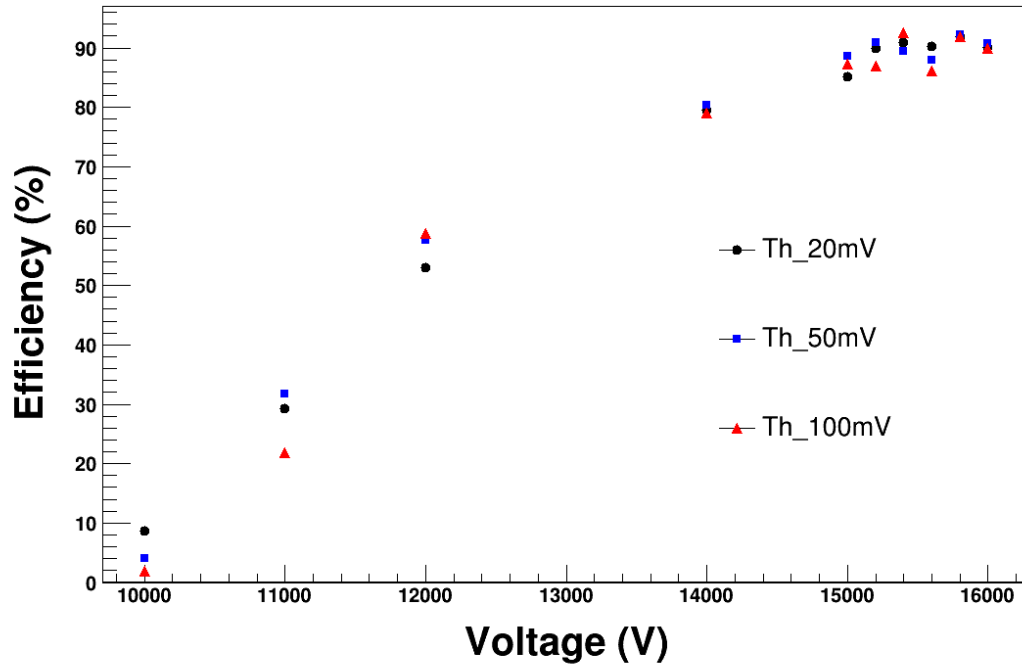
# Detector Specifications

1. Total area of the detector : ~ 15 cm x 15 cm
2. Active area of the MRPC : ~ 14 cm x 14 cm
3. Dimensions of outer electrodes : ~ 15 cm x 15 cm x 0.30 cm
4. Dimensions of inner electrodes : ~ 14 cm x 14 cm x 0.050 cm
5. Thickness of button spacers : ~ 0.024 cm
6. Total gas gap thickness : ~ 0.15 cm
7. Paint Used: Black conducting paint : Special dry thinner :: 1:1 (by volume)

Test number	Gas composition (by volume)	Flow rate (litre/hour)
1	Freon : Iso-butane : SF <sub>6</sub> :: 94.3 : 5.3 : 0.4	~ 0.75
2.	Freon : Iso-butane :: 85 : 15	~ 0.21

# Test results\* for Test number 1

\* Presented in DAE BRNS HEP symposium – 2016 by Mitali Mondal



Efficiency Plateau obtained beyond 15 kV

The plateau shows an efficiency  $> 90\%$

No significant difference in efficiency plateau for change in thresholds.

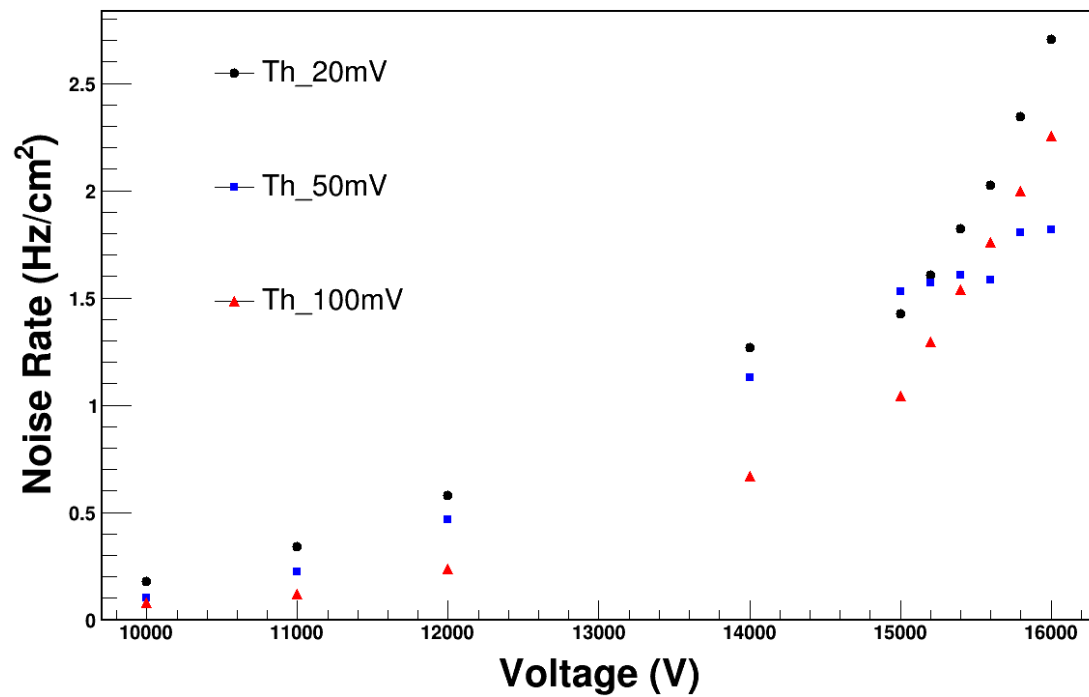
Noise rate is higher for lower threshold value

Maximum Noise rate

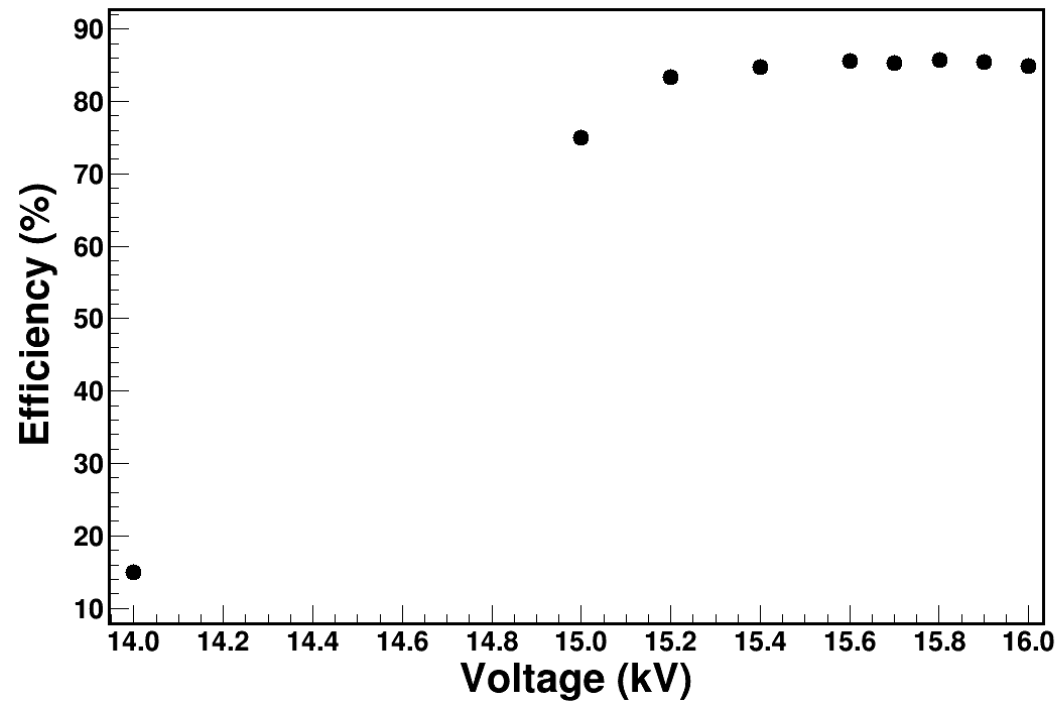
1.8 Hz/cm<sup>2</sup> at 100 mV

2.2 Hz/cm<sup>2</sup> at 50 mV

2.8 Hz/cm<sup>2</sup> at 20 mV



# Test results for Test number 2

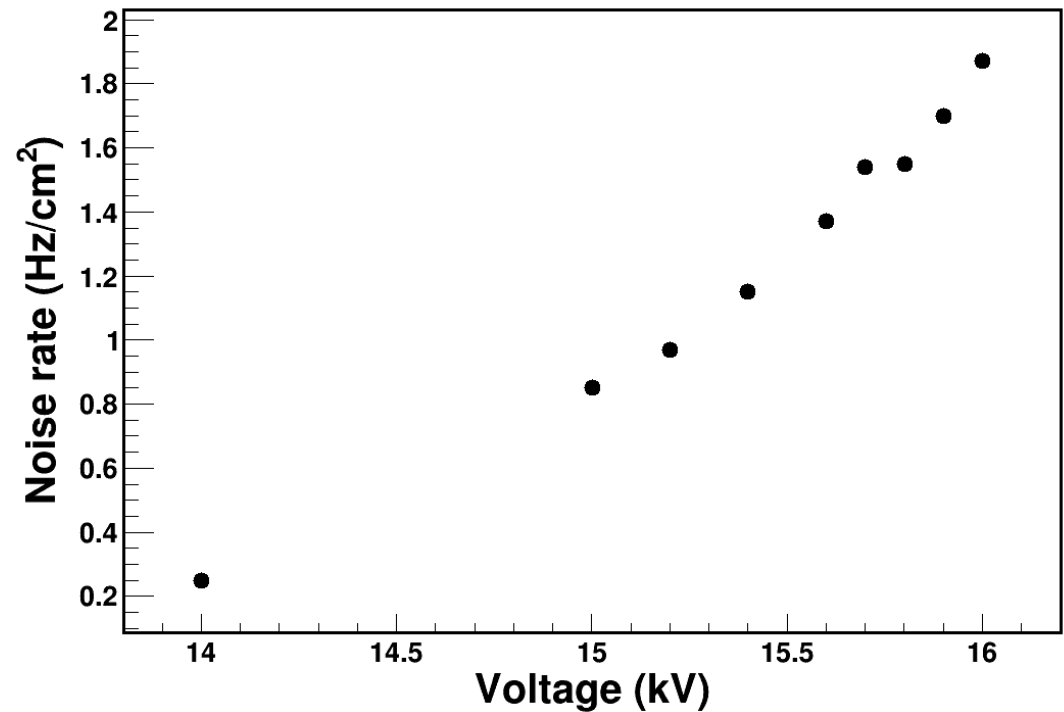


Efficiency Plateau obtained beyond 15.2 kV

The plateau shows an efficiency  $\sim 85\%$

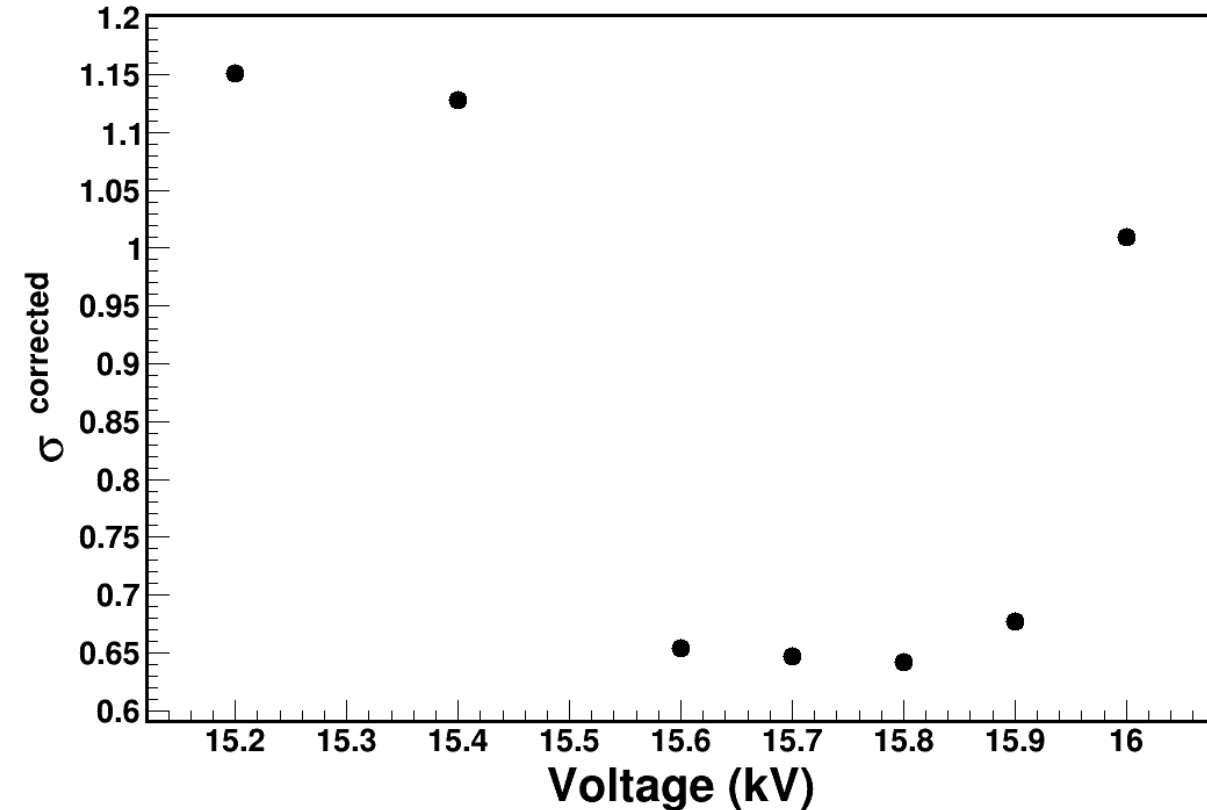
Maximum Noise rate

1.87 Hz/cm<sup>2</sup> @ 16 kV





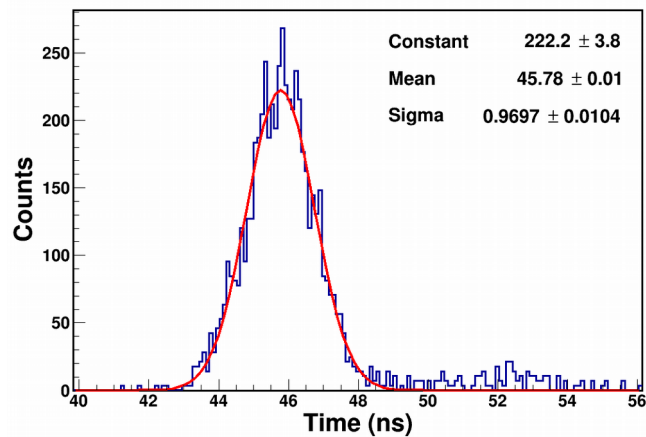
# Time Resolution



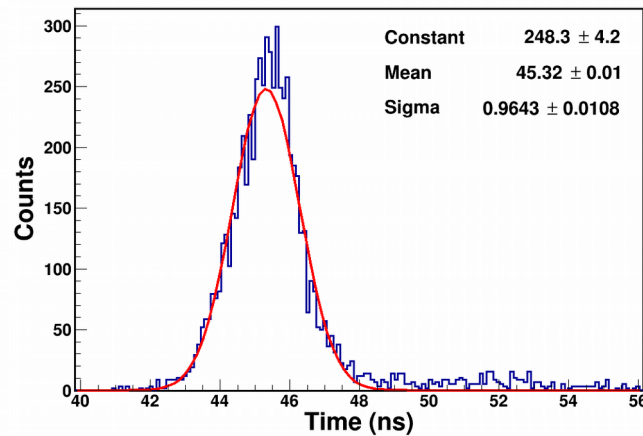
The time resolution first improves with increasing applied high voltage and then deteriorates.

The best time resolution :  
~ 640 ps @ 15.8 kV

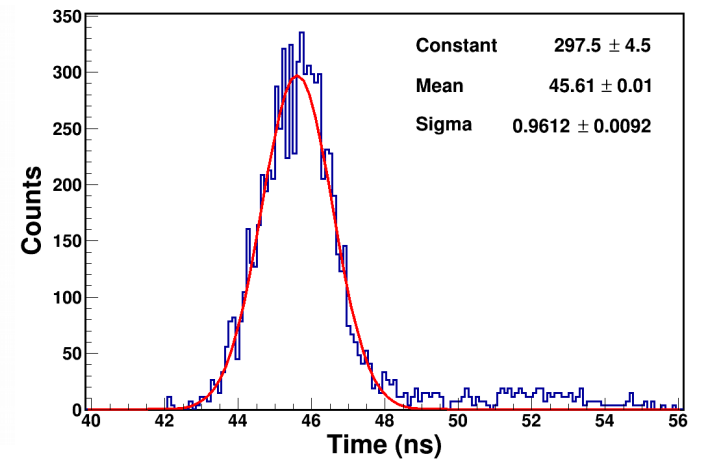
@ 15.6 kV



@ 15.7 kV



@ 15.8 kV



# Summary

1. A six gap bakelite MRPC has been successfully developed.
2. The MRPC was operated in with gas mixtures of

Freon : isobutane : SF<sub>6</sub> :: 94.3 : 5.3 : 0.4  **Efficiency > 90%**

Freon : iso-butane :: 85 : 15.  **Efficiency ~ 85%**

3. The best time resolution obtained is **~ 640 ps @ 15.8 kV**

## Outlook

- To improve the time resolution.
- To measure the photon detection efficiency of the MRPCs.
- To develop a proper set up for TOF-PET imaging.



Any question(s) / comment(s) please.