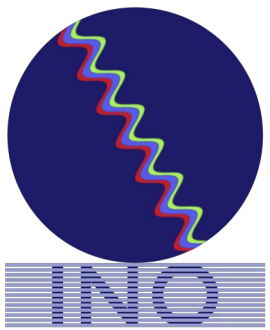
Testing of SiPMs and scintillators for the CMVD

DHEP Annual Meeting

May 6, 2022

Mamta Jangra

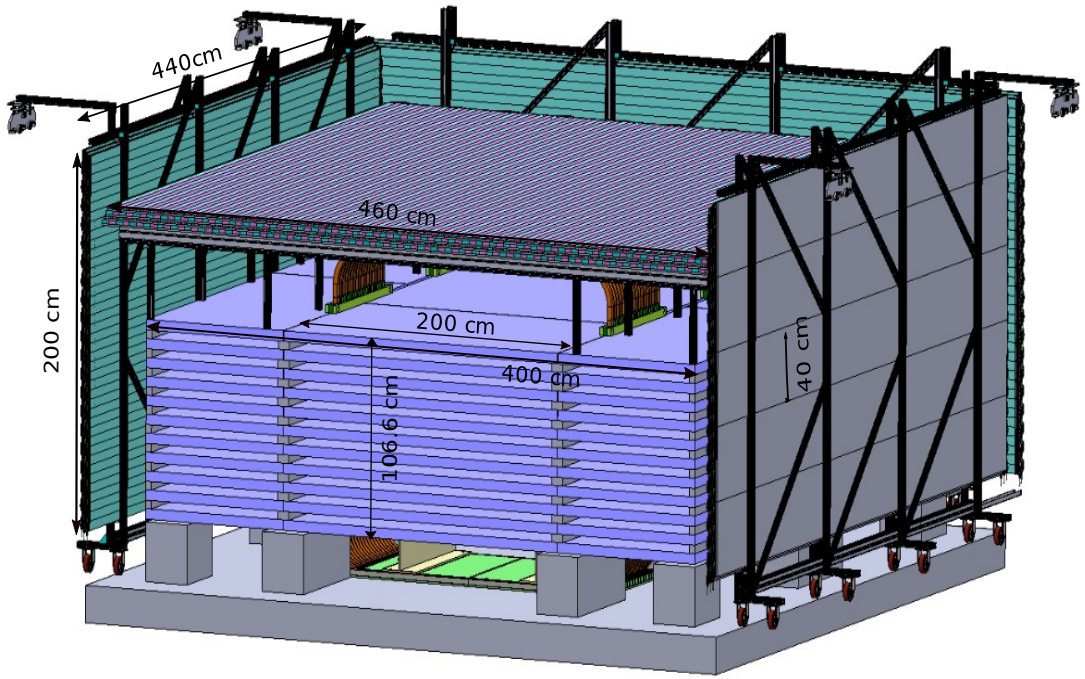
On behalf of INO Group



Outline

- Motivation
- SiPM mass testing
- Scintillator testing
- Summary

Motivation : Cosmic Muon Veto Detector



- CMVD with veto efficiency more than 99.99%
- 720 extruded scintillator strip (counter)
- 2848 Silicon-PhotoMultipliers (SiPMs)

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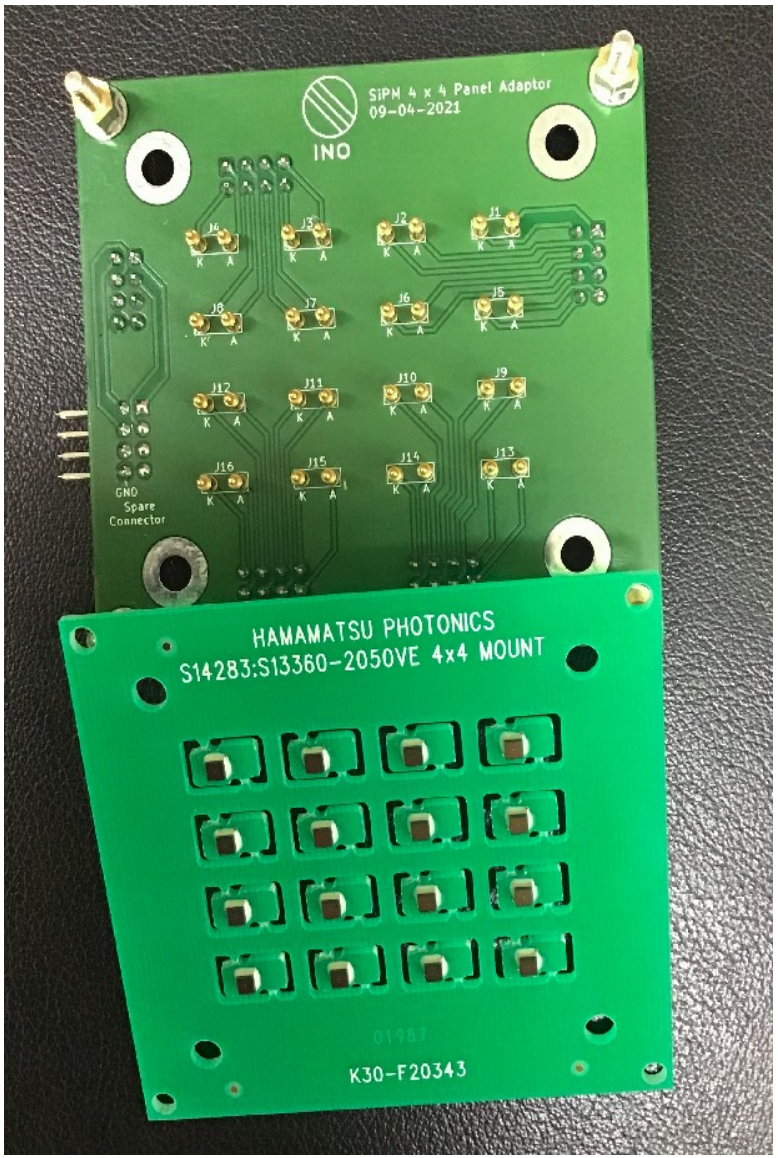
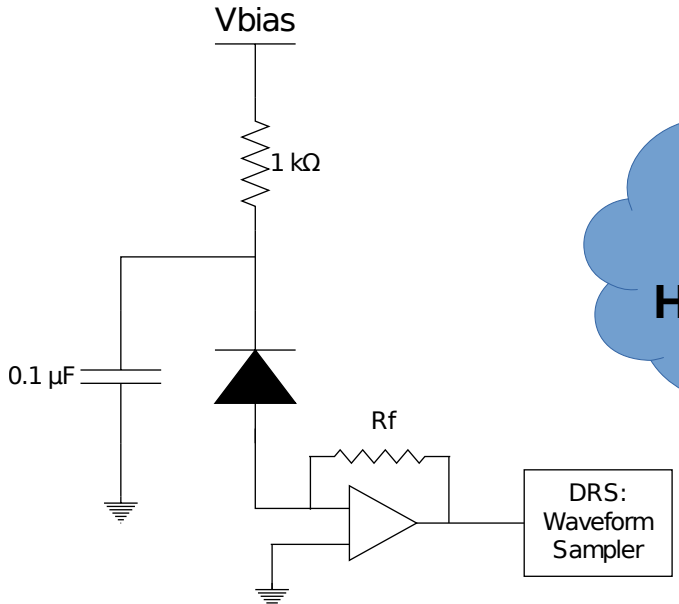
About SiPM

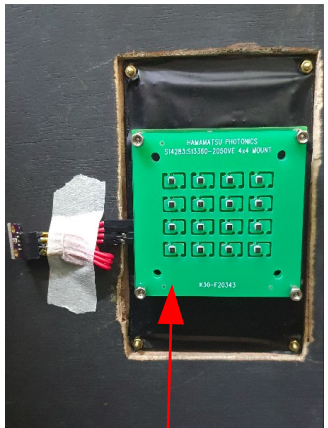


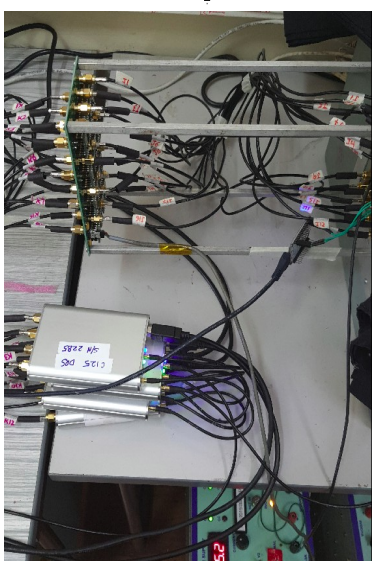
- S13360-2050VE Hammamatsu
- 2mm x 2mm with 1584 pixels, microcell of 50 um pitch, fill factor of 74%
- Overvoltage (V_{ov}) = V_{bias} - V_{bd}, V_{bd} : (53 ± 5)V
- Spectral range : 320 - 900 nm

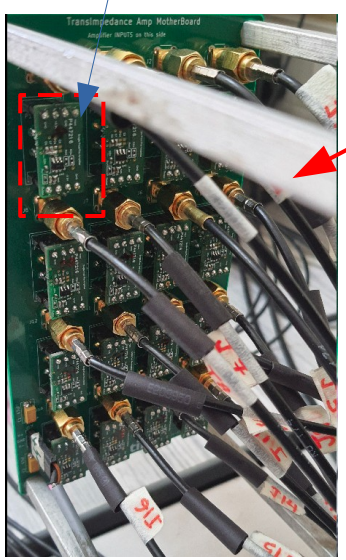
SiPM Mass Testing : Experimental setup

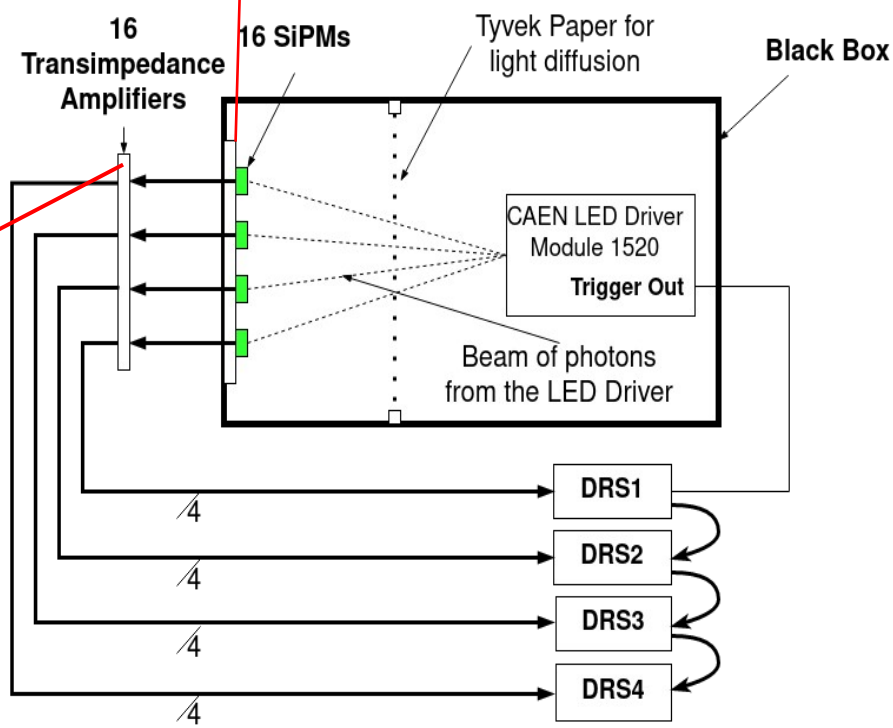


TI amplifier designed by **HAGAR** group

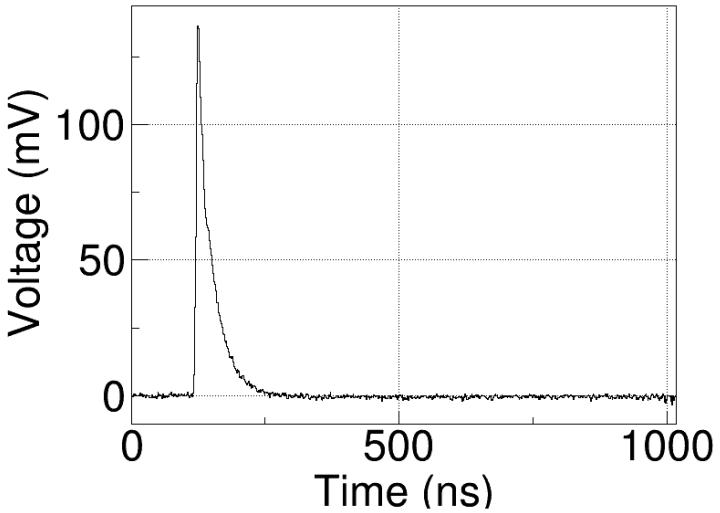






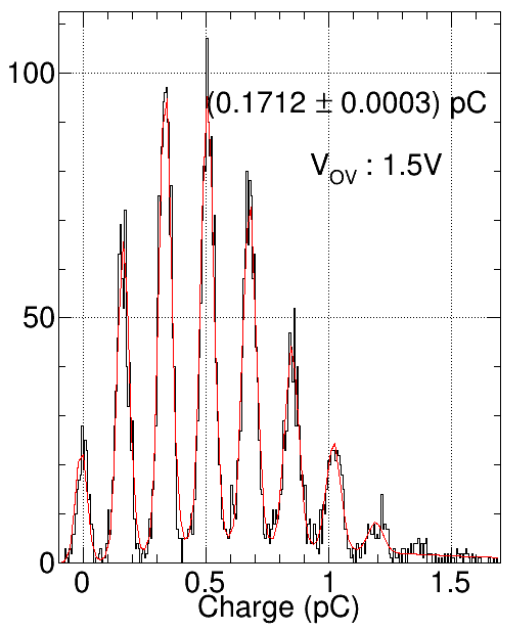


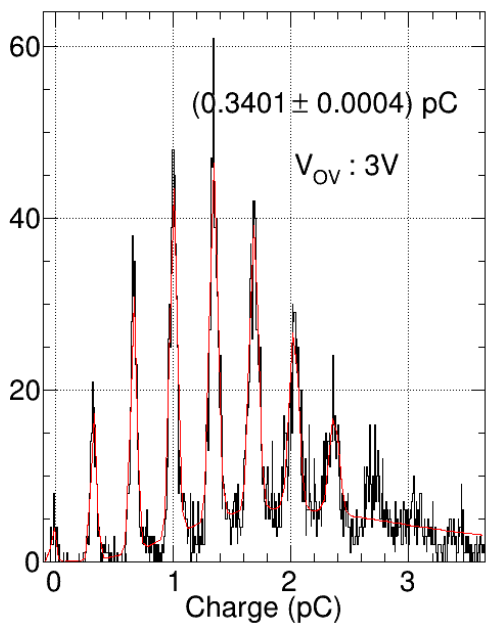
SiPM Testing Results

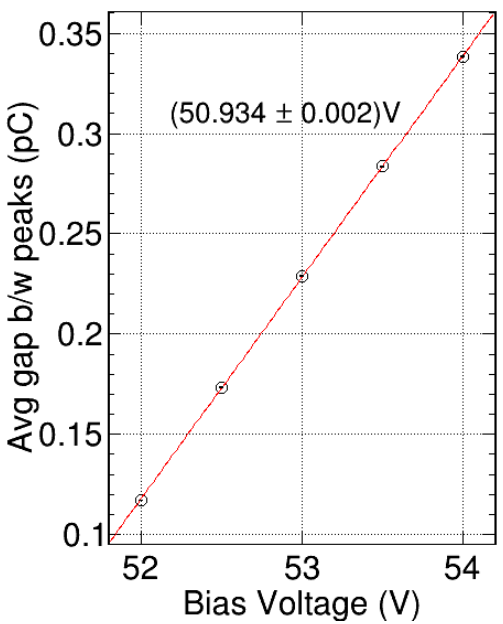


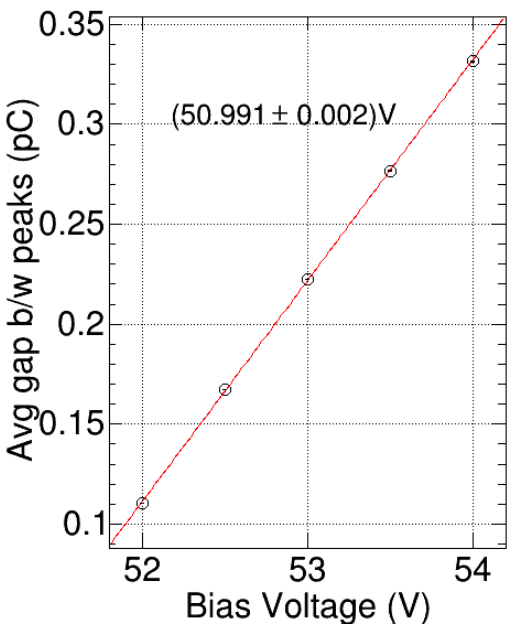
- A total of 218 panels were tested.
- Each panel has 16 SiPMs.
- Total 3488 SiPMs were tested.

$$f(q) = Landau(q) + \sum_{n=0}^{N-1} R_n \times exp\left(-\frac{(q - n \cdot \mu)^2}{2\sigma^2}\right)$$

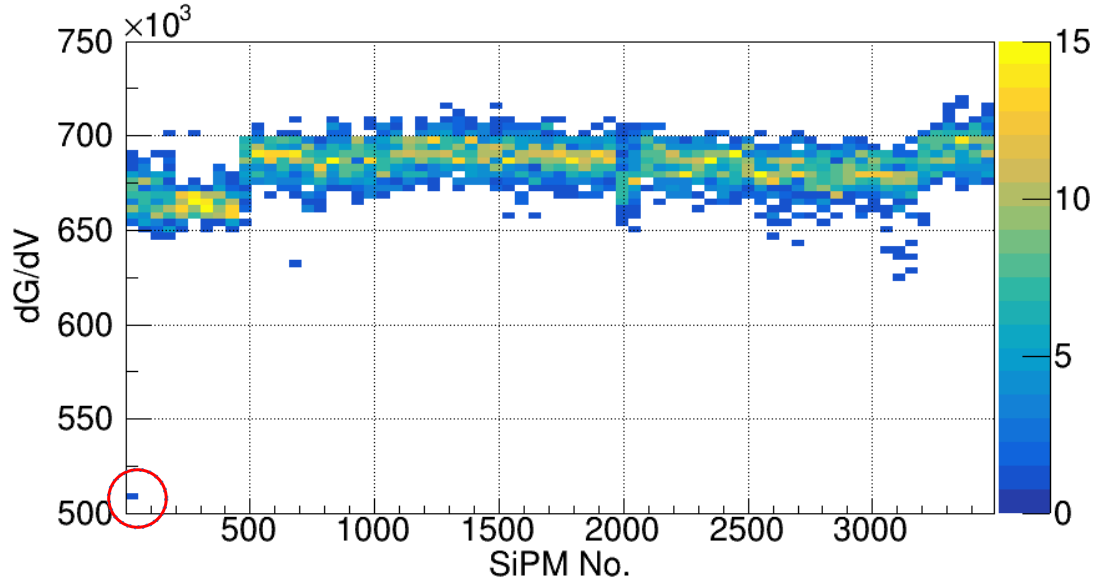


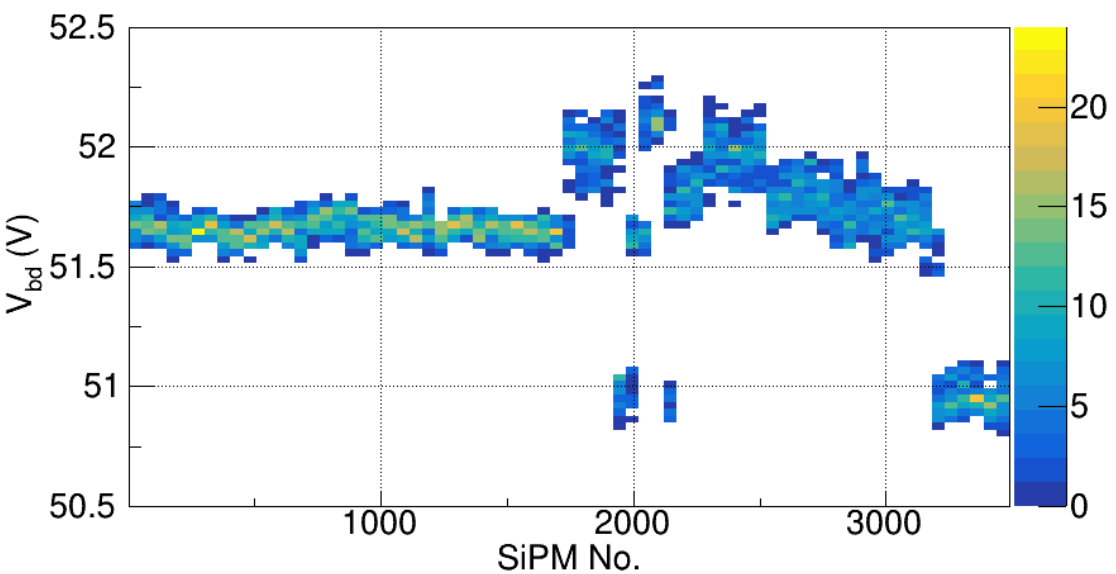






Summary from SiPM Testing Results

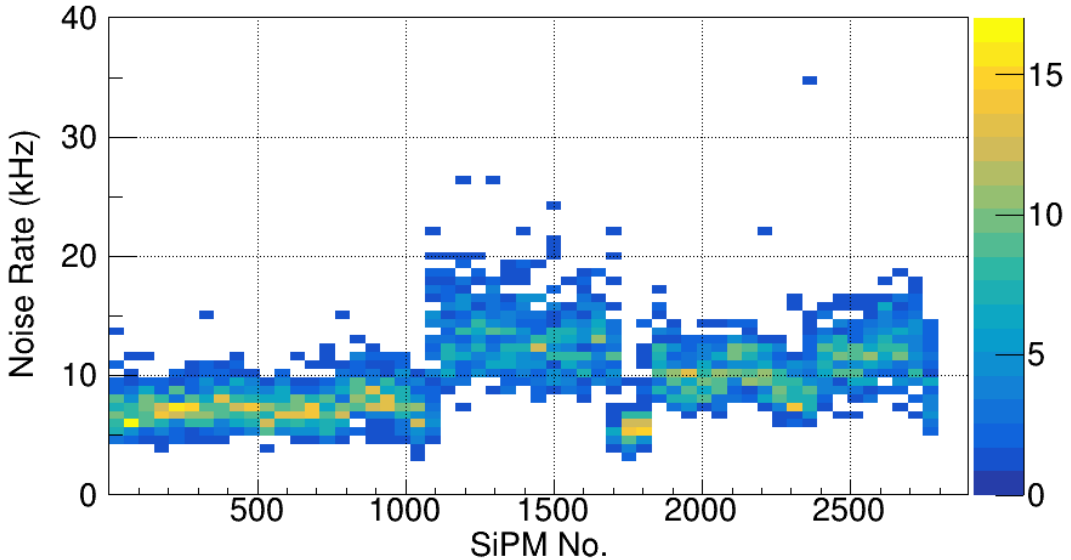




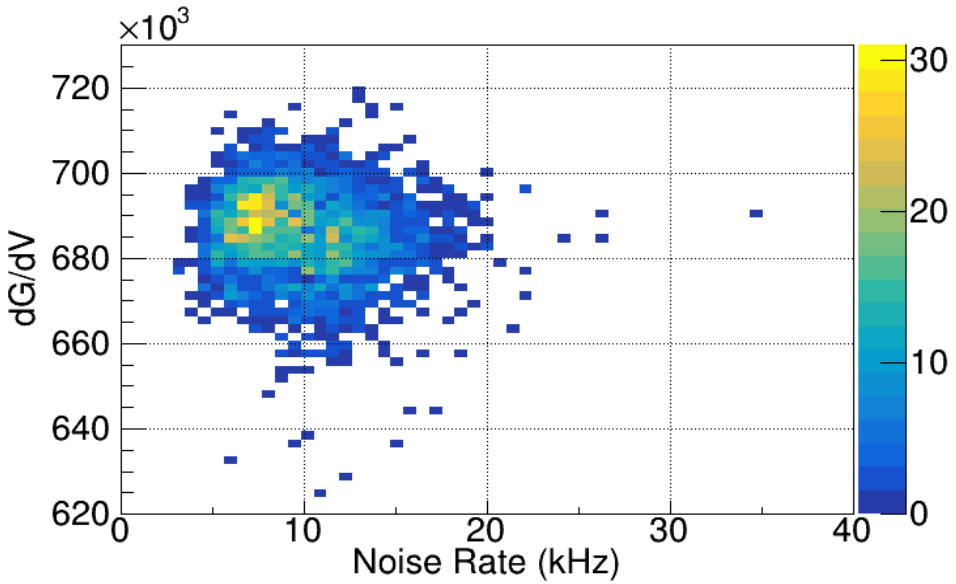
- Out of total 3488 SiPMs, one SiPM is found to be bad and one SiPM has low gain.

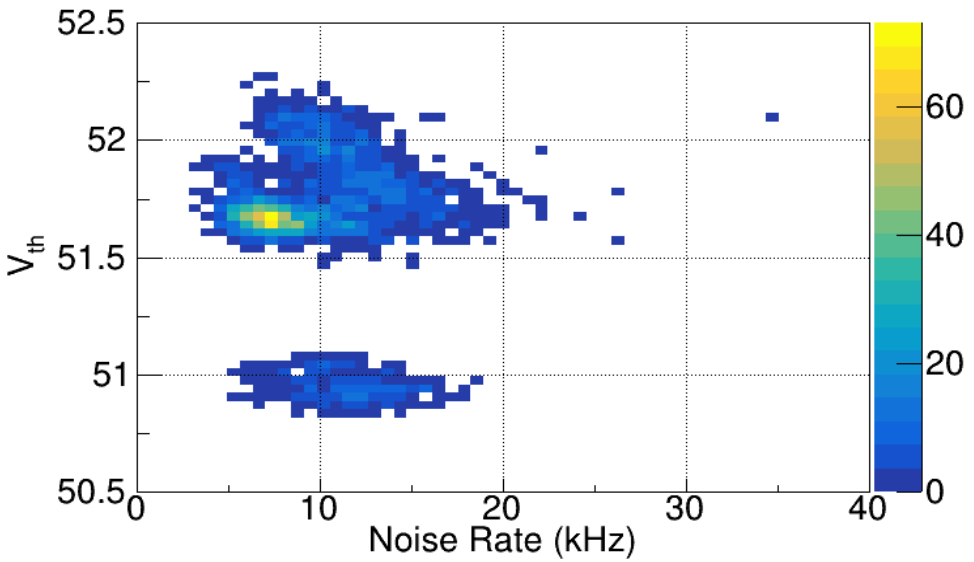
- A total of 3 sets of values are obtained for breakdown point of the SiPM.

Summary from SiPM Testing Results



- 1pe = 0.32 pC @ V_{ov} = 3V, the noise rates are calculated at 0.48 pC.
- No correlation is found b/w noise rates and other parameters.





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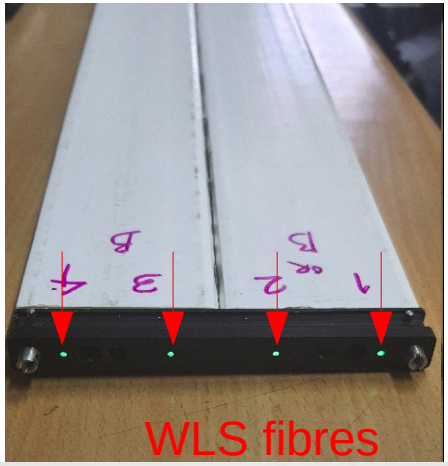
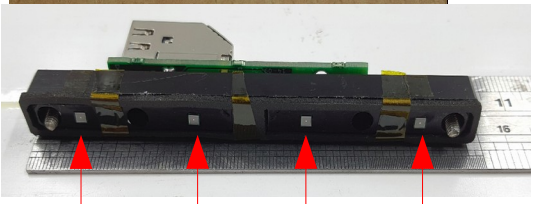
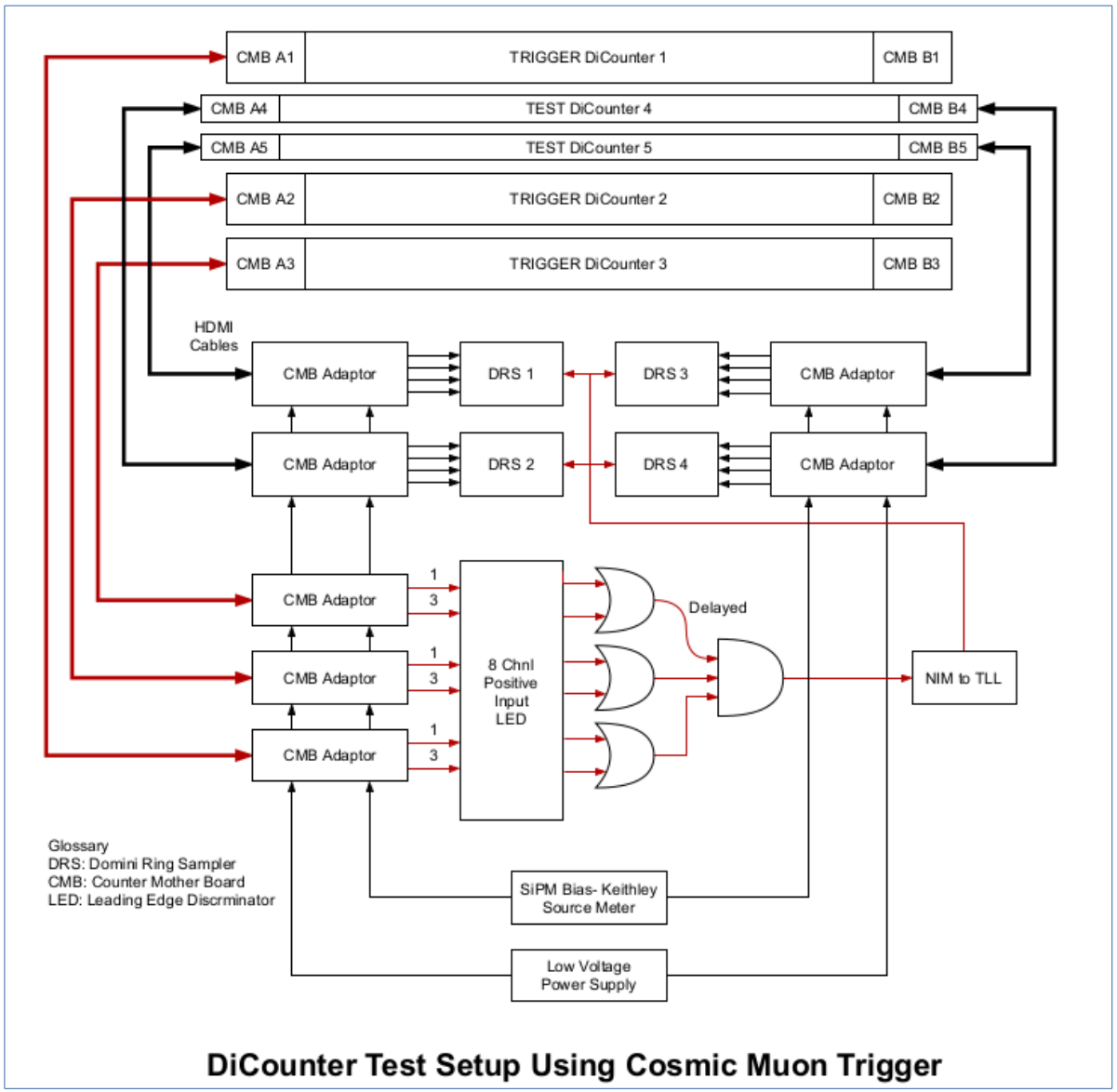
Di-counter Testing : Experimental setup





- 2 di-counters were tested at a time
- 3 di-counters were used for trigger generation

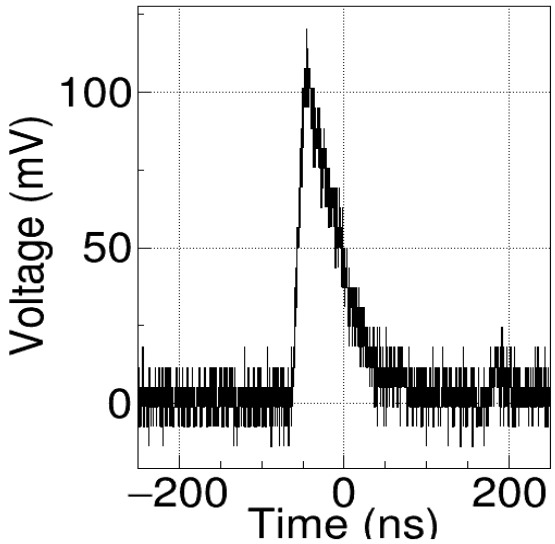
Di-counter Testing : Cosmic Muon Trigger Formation

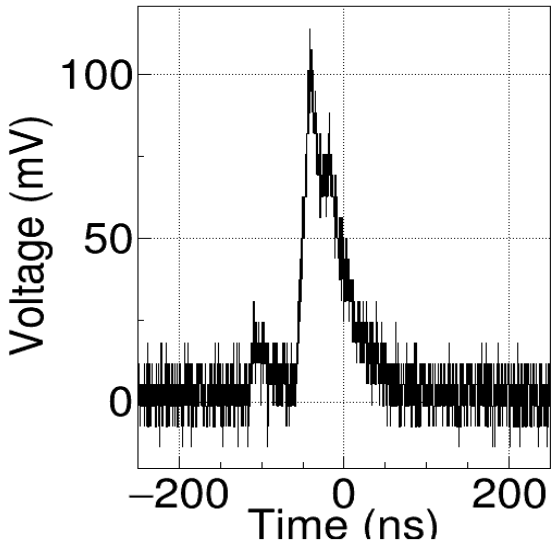


DiCounter Test Setup Using Cosmic Muon Trigger

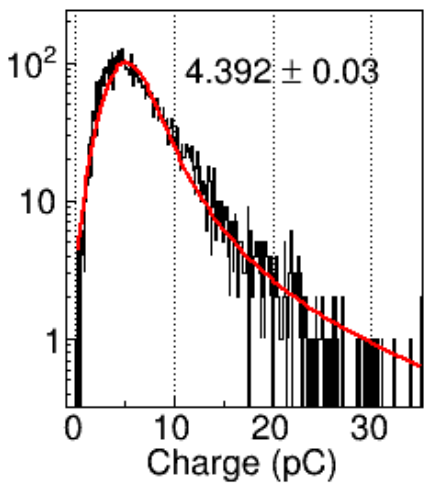
- A total of 3 di-counters are used for trigger.
- Trigger is generated only from one side of the di-counter.
- A1 and A3 channels i.e. one channel from each counter is used for trigger generation.
- Final trigger is generated by making AND(OR(A1,A3),.....).

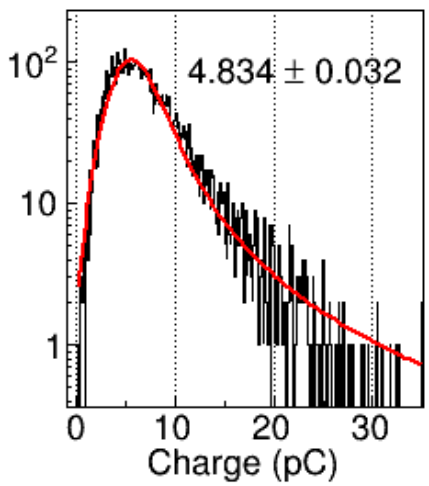
Scintillator Testing Results

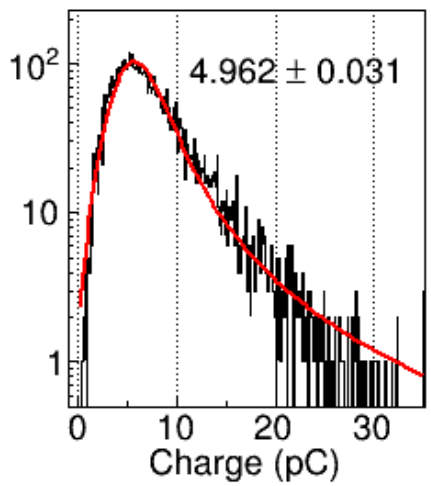


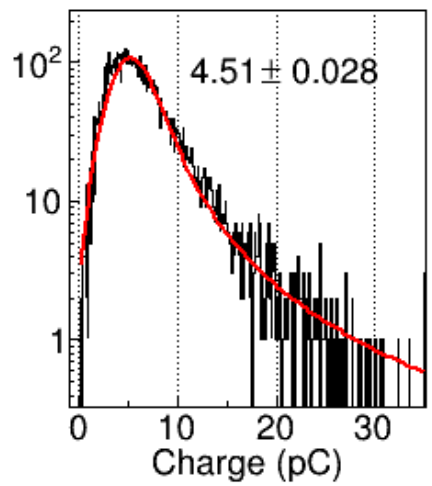


Cosmic muon signals



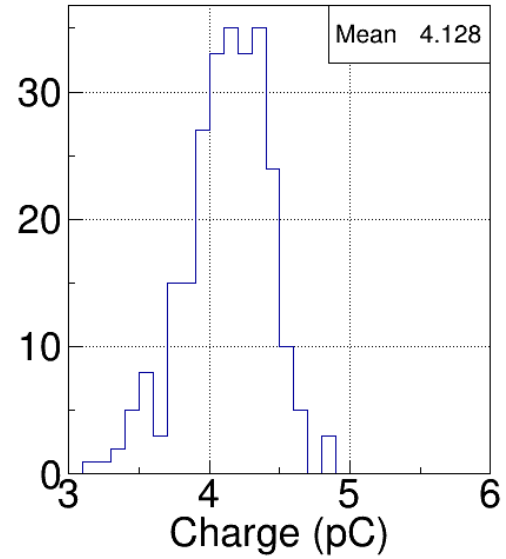


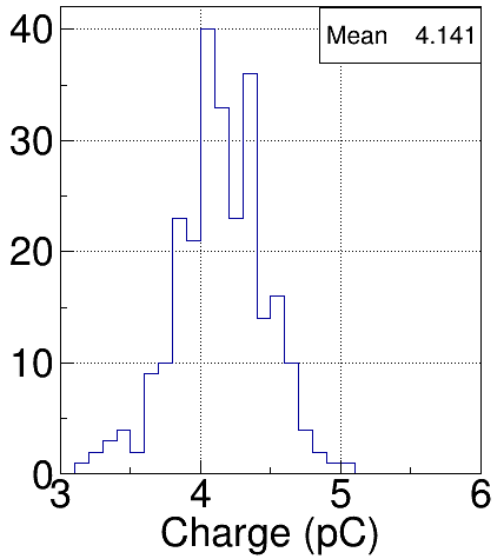


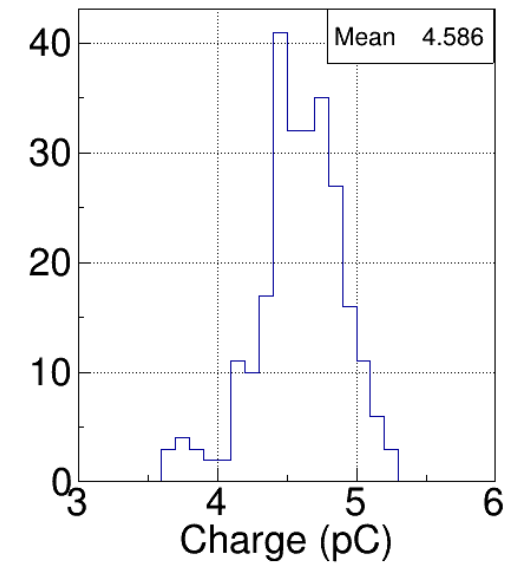


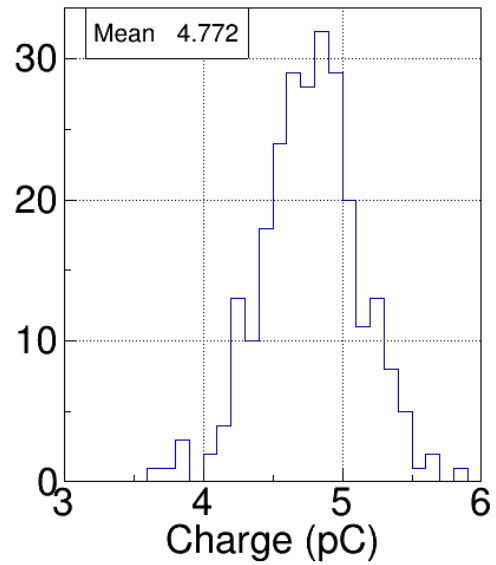
Muon charge distrubution for 4 SiPMs of one side of the di-counter

Scintillator Testing Results

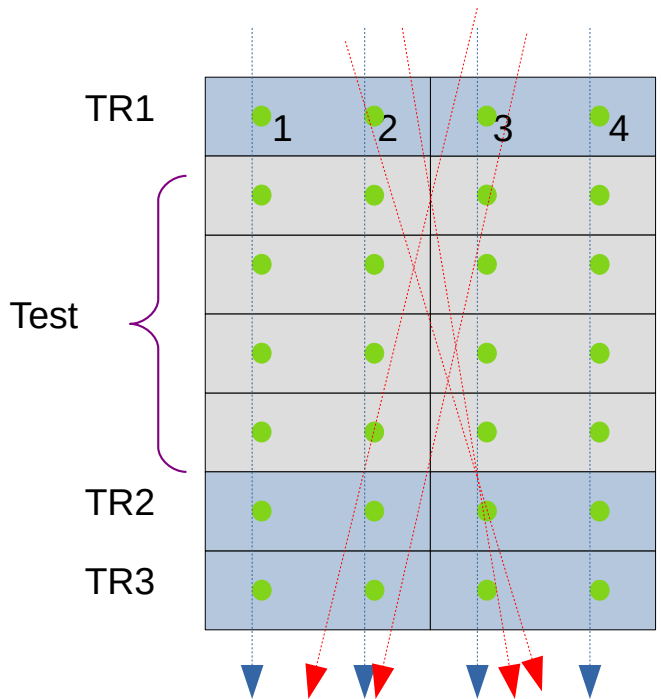






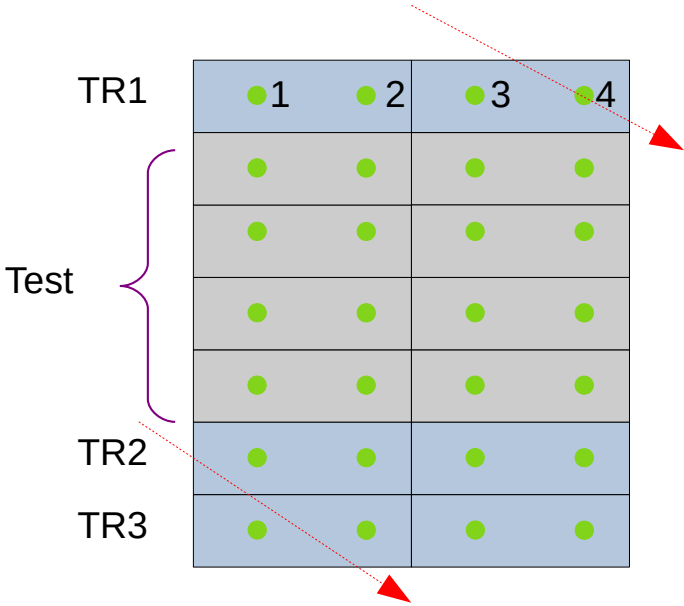


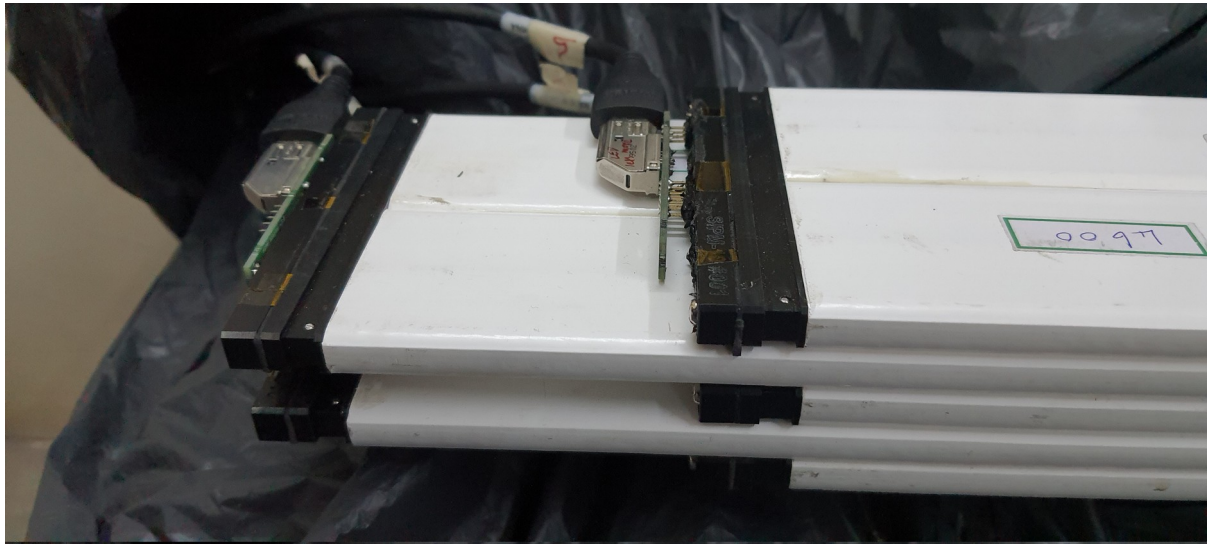
- The middle SiPMs of the dicounter have more charge collection as compared to the SiPMs on the edges.



Scintillator Testing Results

Around 1% inefficiency was observed with this geometry.





2 test dicounters were sandwiched b/w 3 trigger dicounters, inefficiency reduced to less than 0.3%

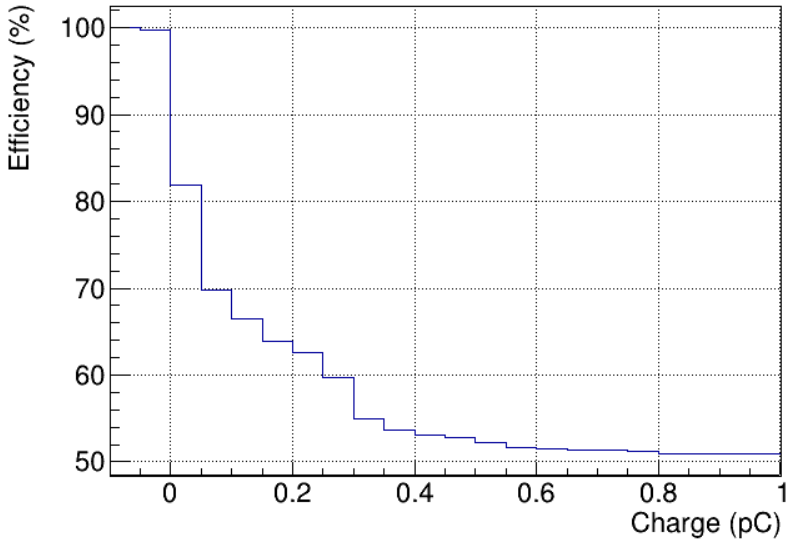
Di-counter Testing : Summary

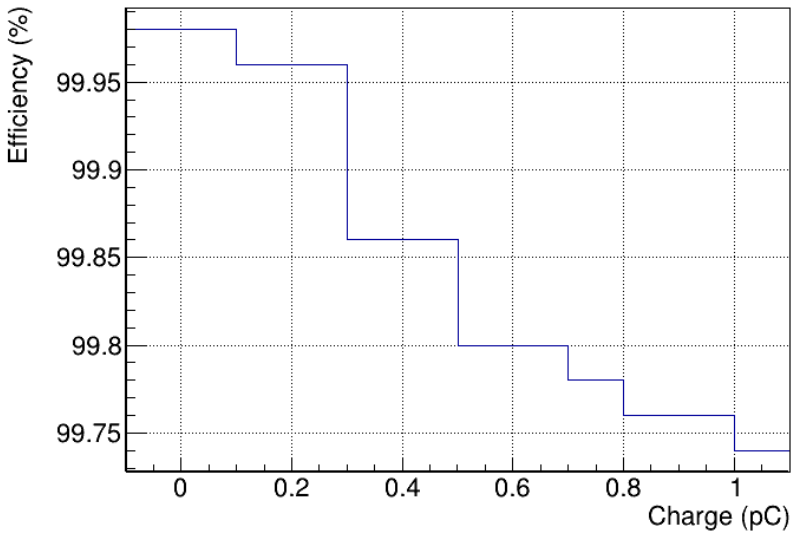
Tested so far				Required
4.5 m	4.6 m	4.7 m	Total	
86	120	61	267	356

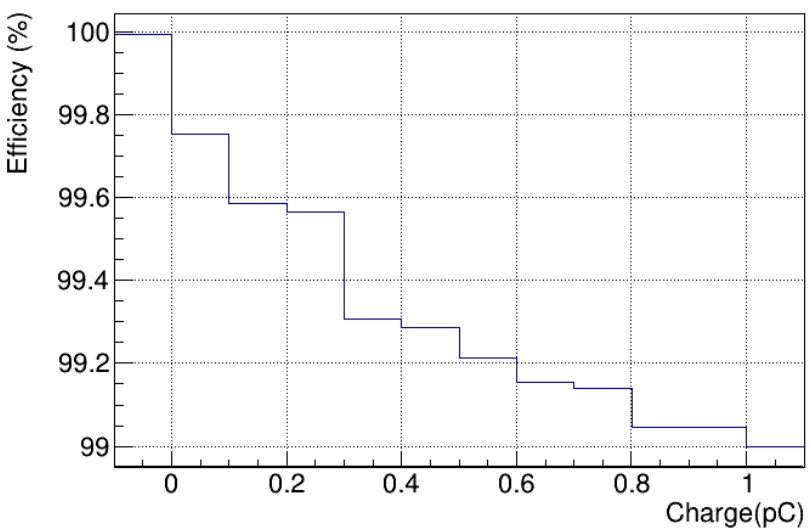
All the tested dicounters passed cosmic test except one, but reused later.

THANK YOU

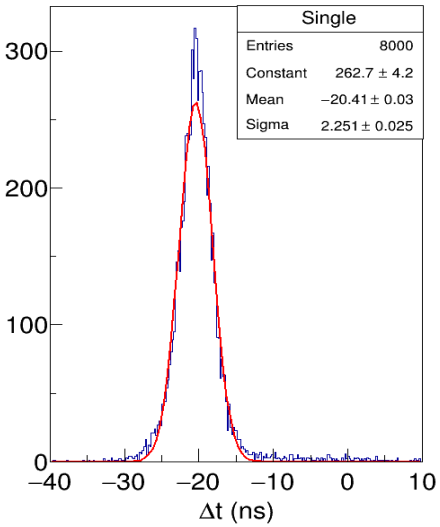
Backup

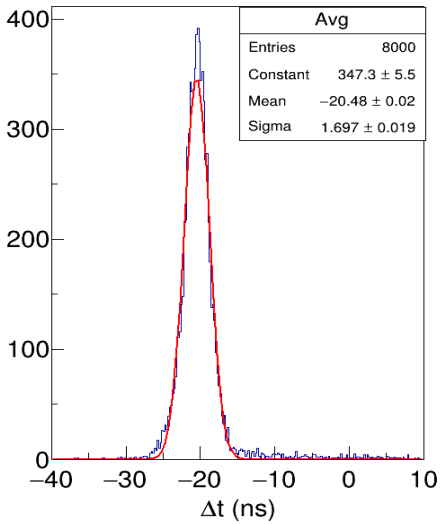

Efficiency (%)
100
90
80
70
60
50
0
0.2
0.4
0.6
0.8
1
Charge (pC)

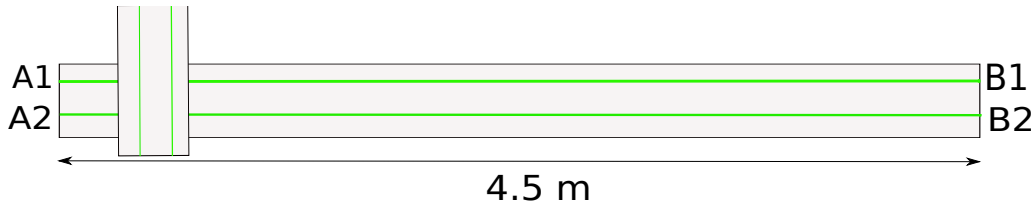

Efficiency (%)
99.95
99.9
99.85
99.8
99.75
0
0.2
0.4
0.6
0.8
1
Charge (pC)

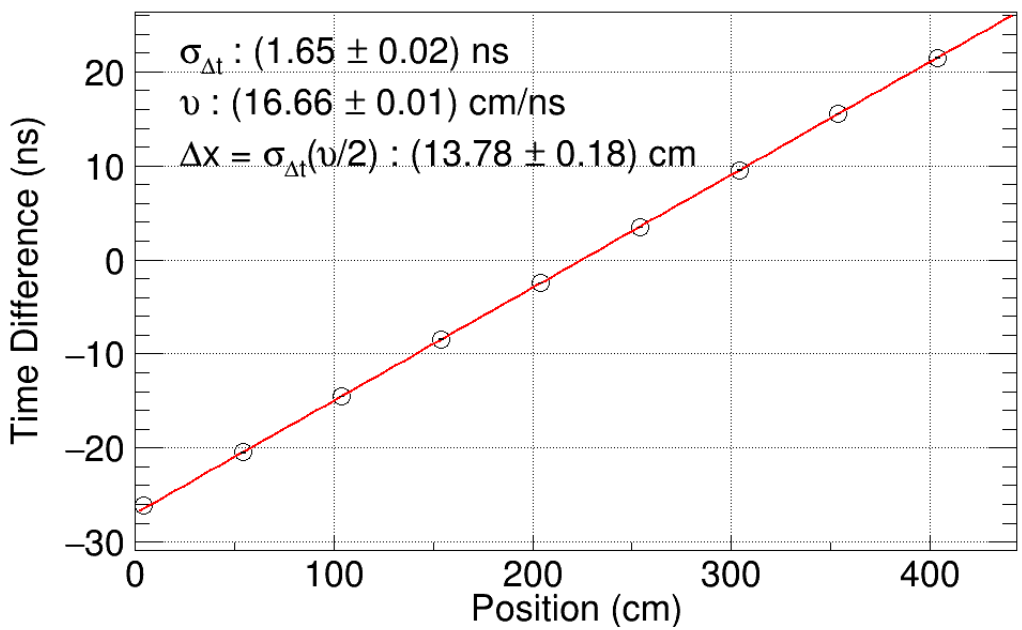

Efficiency (%)
100
99.8
99.6
99.4
99.2
99
0
0.2
0.4
0.6
0.8
1
Charge(pC)

Backup


Single
Entries 8000
Constant 262.7 ± 4.2
Mean −20.41 ± 0.03
Sigma 2.251 ± 0.025
Δt (ns)


Avg
Entries 8000
Constant 347.3 ± 5.5
Mean −20.48 ± 0.02
Sigma 1.697 ± 0.019
Δt (ns)


A1
A2
B1
B2
4.5 m


σΔt : (1.65 ± 0.02) ns
υ : (16.66 ± 0.01) cm/ns
Δx = σΔt(υ/2) : (13.78 ± 0.18) cm
Time Difference (ns)
Position (cm)