Charge Threshold study of a glass RPC in Avalanche Mode

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XXIII DAE-BRNS HIGH ENERGY PHYSICS SYMPOSIUM 2018,
December 10-14, 2018
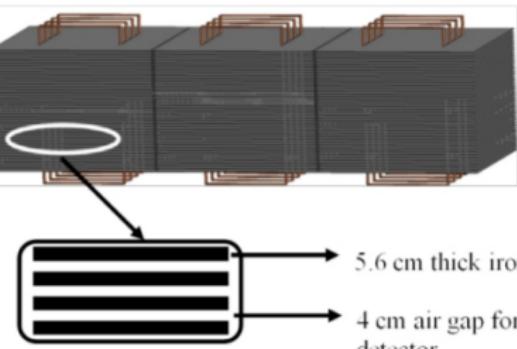
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ICAL at INO
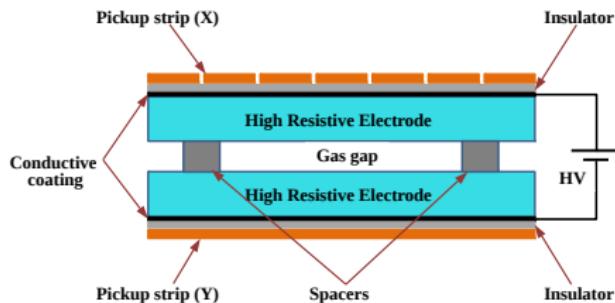
Schematic view of the ICAL detector

- Iron-CALorimeter(ICAL) is a proposed magnetised detector which will be built in the INO cavern to study atmospheric neutrinos.
- three modules each of size : $16m \times 16m \times 14.5m$.
- 151 layers of 5.6 cm thick iron plates interleaved with 4 cm gaps to house the RPCs.
- 28,800 RPCs of $2m \times 2m$ area, with 64 strips (strip pitch 30 mm) on either read-out planes.

5.6 cm thick iron plate

4 cm air gap for RPC detector

Physics White Paper of the ICAL (INO) Collaboration

Resistive Plate Chambers

- Resistive Plate Chambers (RPC) are operated in avalanche mode.
  Gases : R134a (95.5%), isobutane (4.2%) and SF_6 (0.3%).

- High resistive electrodes: Glass/Bakelite($10^{12} - 10^{13}$ Ω-cm)with 2mm gap.

- Constant and uniform electric field ($E \approx 5$ kV/mm) is maintained.
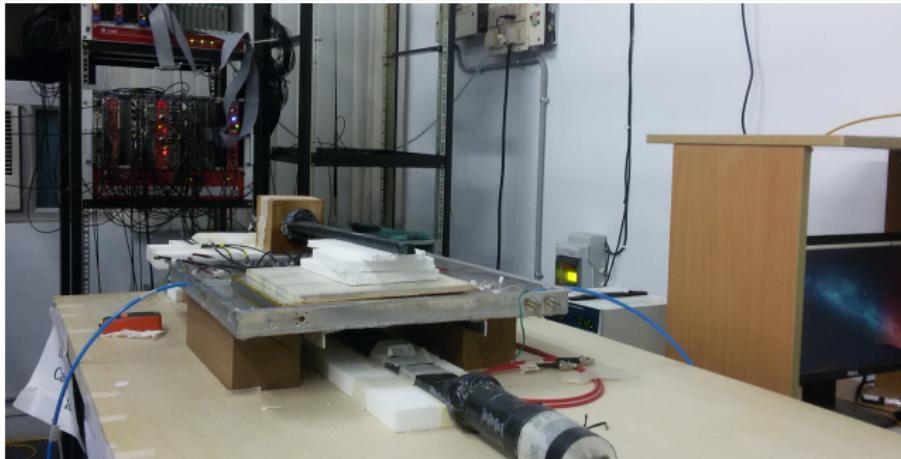

Schematic of the RPC

- RPCs are widely used in High Energy Physics experiments:
  - ► Excellent time resolution (~ 1 ns).
  - ► Relatively simple and cheap construction.
  - ► Good efficiency ($> 90\%$).
 - ► Two dimensional readout system.
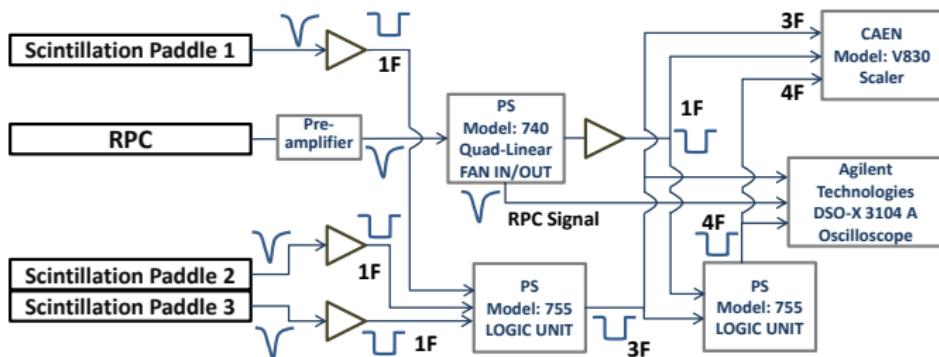
Motivation

- Currents (in I-V characteristics) depends on applied voltage and shows a threshold behavior
  - Model PS705 consists of eight channels with individual threshold control which can be varied from -10mV to -1V
- Threshold voltage to minimize noise
- Shape of charge distribution is almost gaussian which allows to set a finite threshold without losing efficiency
- Simulation and past experience shows threshold of about 20fC allows detector to achieve full efficiency with smaller streamer probability(3)
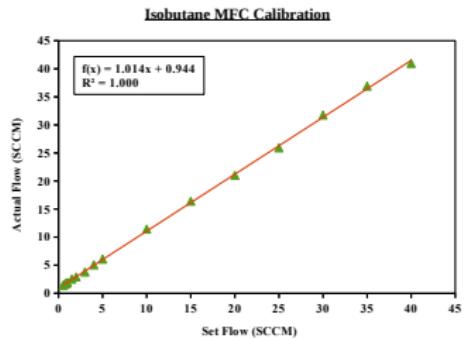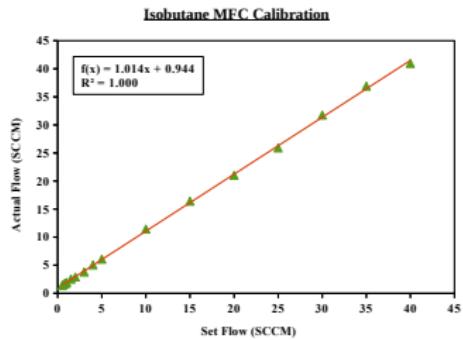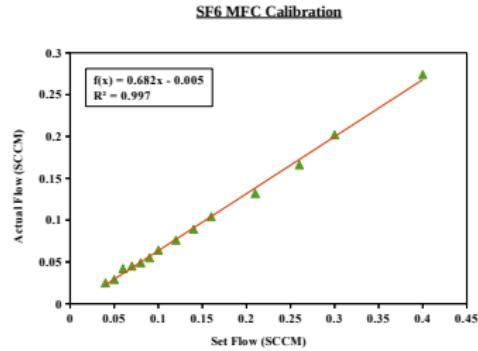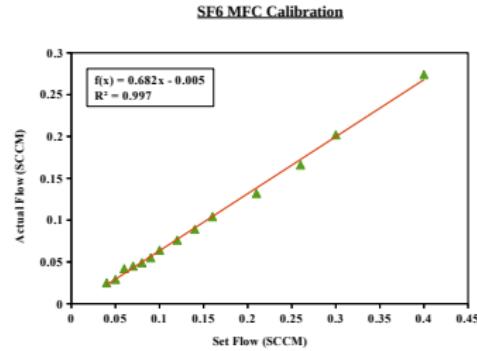
# Experimental setup


Experimental setup.
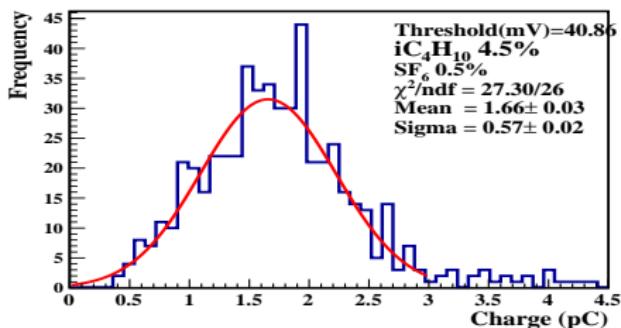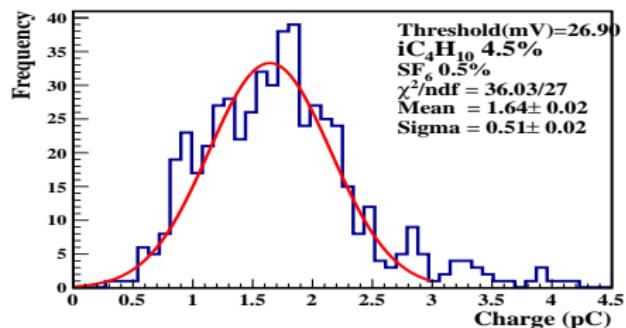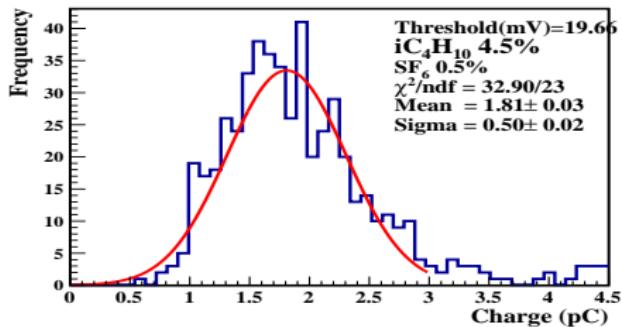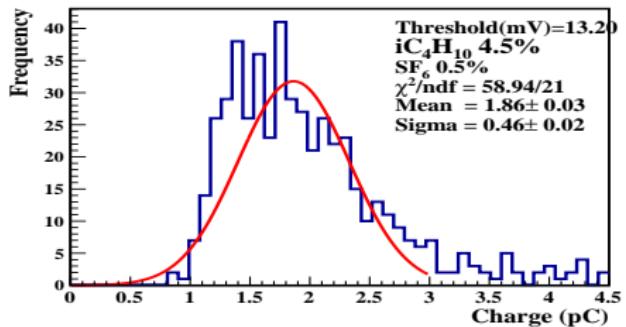
Calibration of MFCs
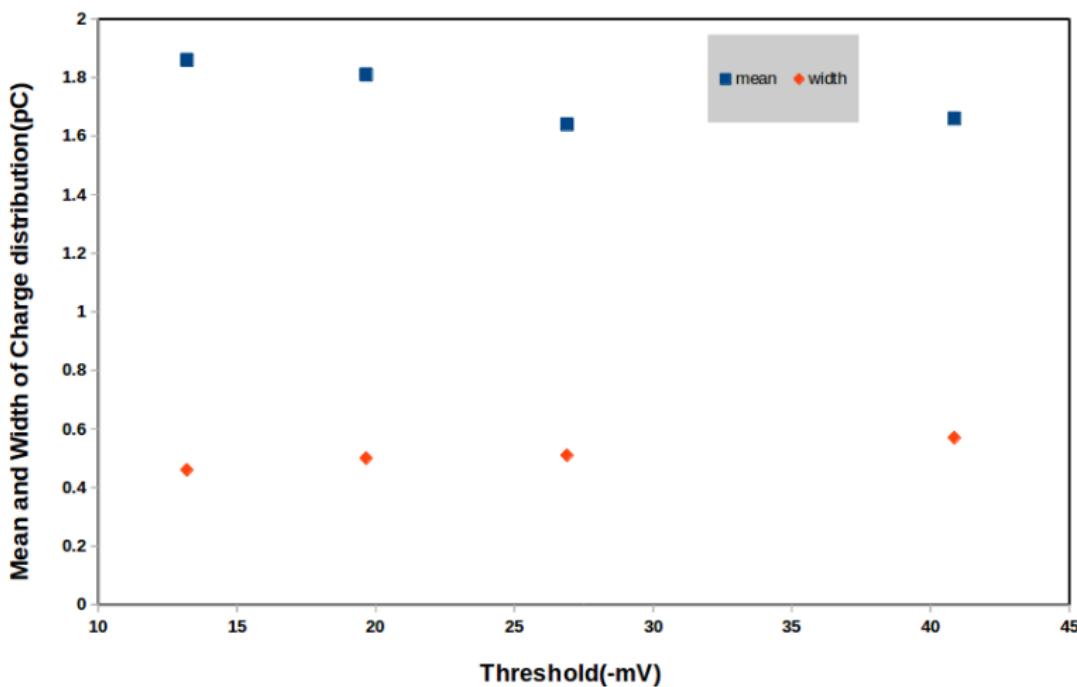
# Effect of Threshold variation on the performance of RPCs

Charge distribution
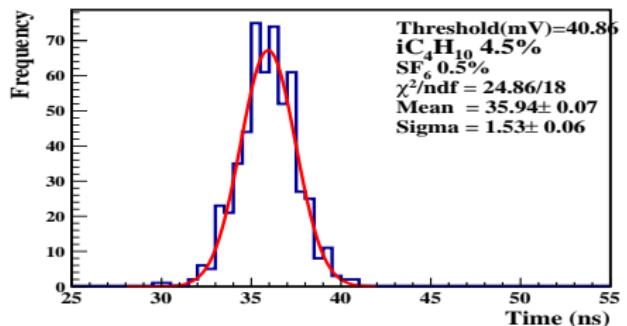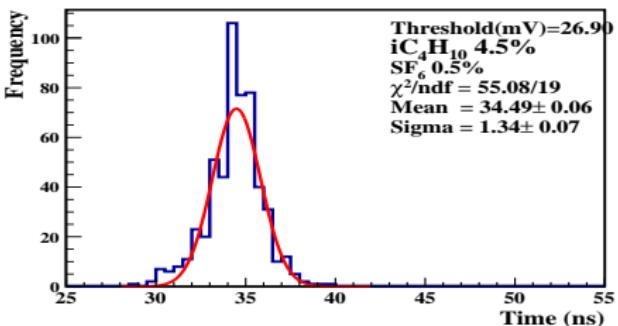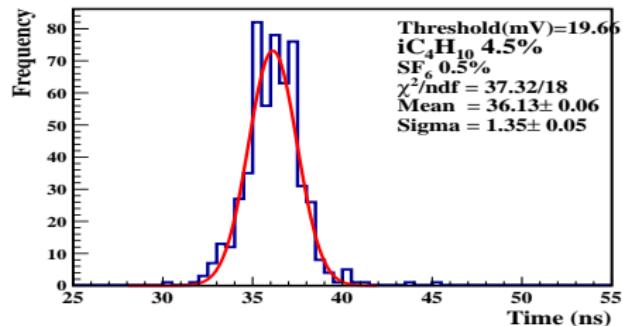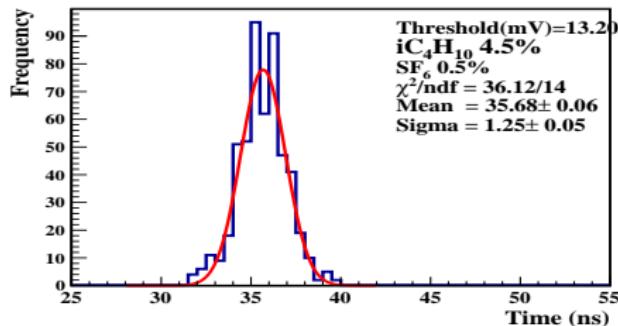
Mean and Sigma of Charge.
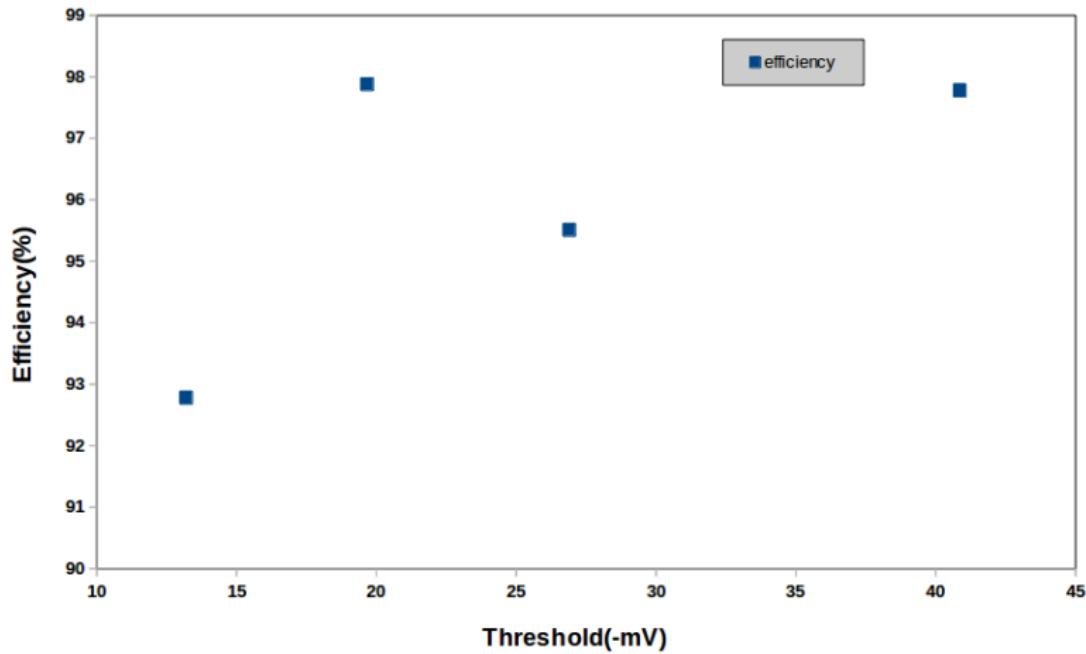
Effect of Threshold variation on the performance of RPCs

Time resolution

Efficiency

Summary:

Future Plans

- Finding charge threshold of corresponding applied voltage.

- Measurement of noise rate (which depends on voltage) to minimize the noise.

- Variation in efficiency with threshold in different voltage.

Conclusion

We have used $30 \times 30 cm^2$ single gap RPC at 10.4kV and at $19 degreeC$

- Mean of the charge distribution decrease with increasing threshold voltage

- Efficiency is highest $\sim 19.66 mV$ (needs more statistics to get better pattern)

References:

(1). S. Abe, et al. [KamLAND Collaboration], Precision Measurement of Neutrino Oscillation Parameters with KamLAND, Phys. Rev. Lett. 100 (2008) 221803

(2). S. Ahmed et al., Invited review: Physics potential of the ICAL detector at the India-based Neutrino Observatory (INO), Pramana 88 (2017) 79

(3). https://www.nevis.columbia.edu/ chi/rpc/cms-rpc-tech-note.pdf

Backup slides:A triggered muon pulse