Characterization and stability tests of gas-tight RPC for muography application

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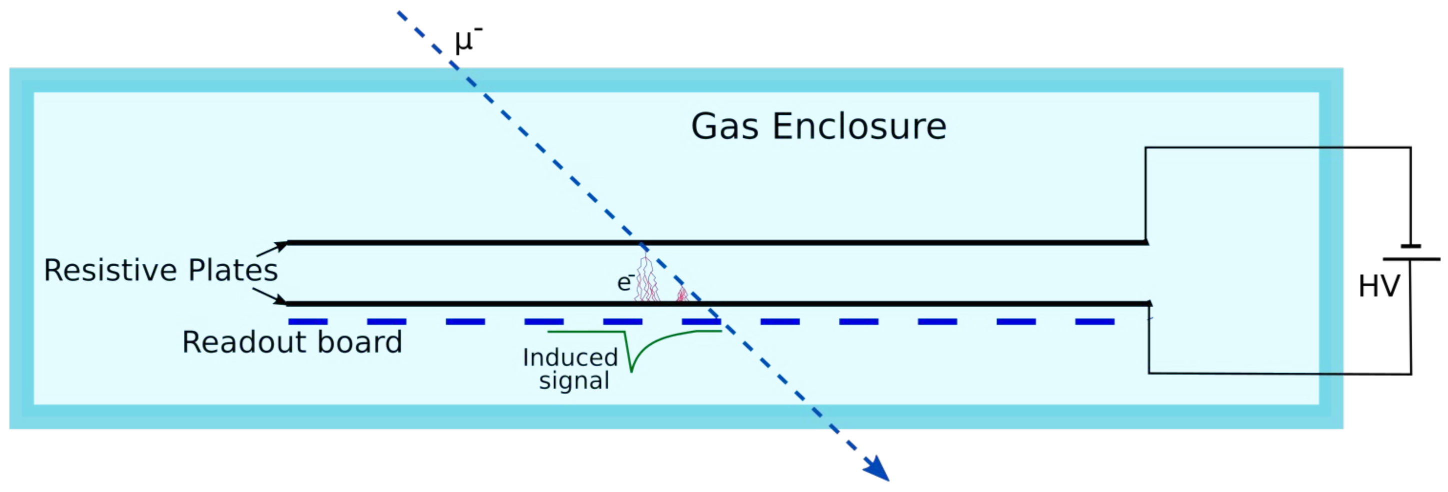
Motivation

- Muography uses cosmic rays to scan objects exploiting the interactions of muon with target material [1].
- Building an RPC based muography system for scanning objects for cultural heritage and anomaly detection [2].
- RPCs are chosen for their simplicity, good performance, and cost-effectiveness.

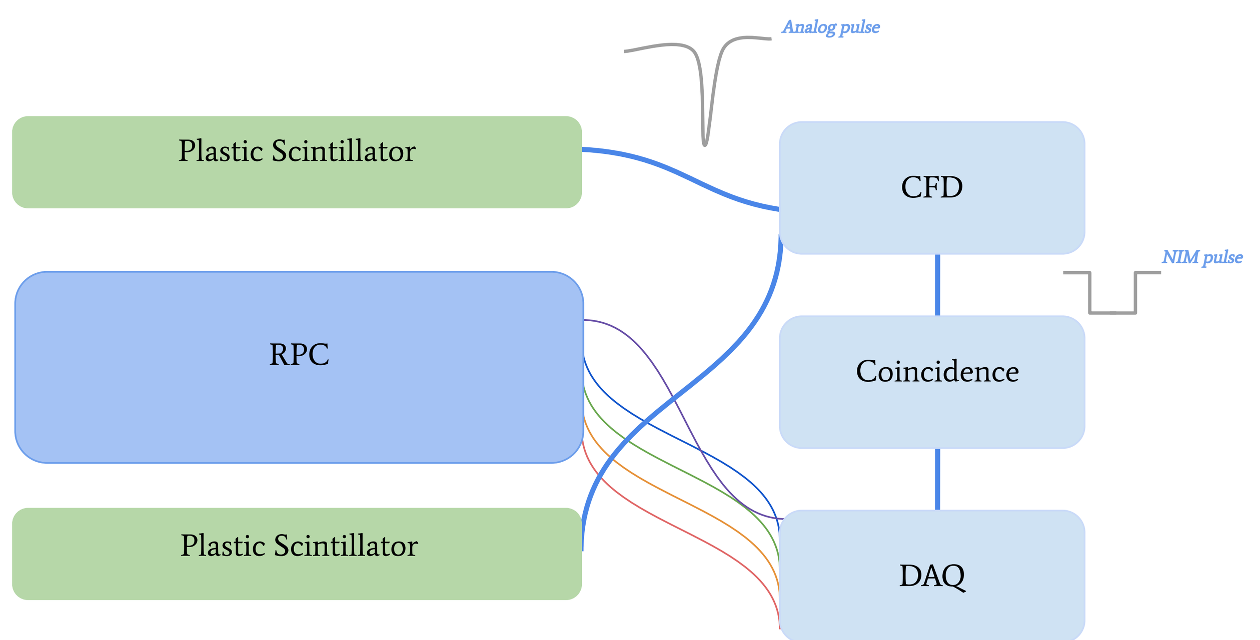
Gas-tight RPC

- Gas-tight RPCs offer a standalone, portable solution compared to traditional RPCs, eliminating the need for complex gas flow infrastructure.
- Our RPC is working with standard 95.2% Freon, 4.5% iso-butane and 0.3% SF6 gas mixture.
- Gas gap between the electrodes is 1 mm and the readout strips are 9 mm wide, placed 1 mm apart.



Experimental setup

- Trigger signal from plastic scintillators
- Signals are collected in parallel with all 16 readout strips
- DAQ consists of CMS's RPC Front End Board that has charge sensitive preamplifiers and discriminators
- The digital discriminator pulse is processed by FPGA for data collection
- The data are collected from pre-trigger as the scintillators signals are delayed with respect to RPC

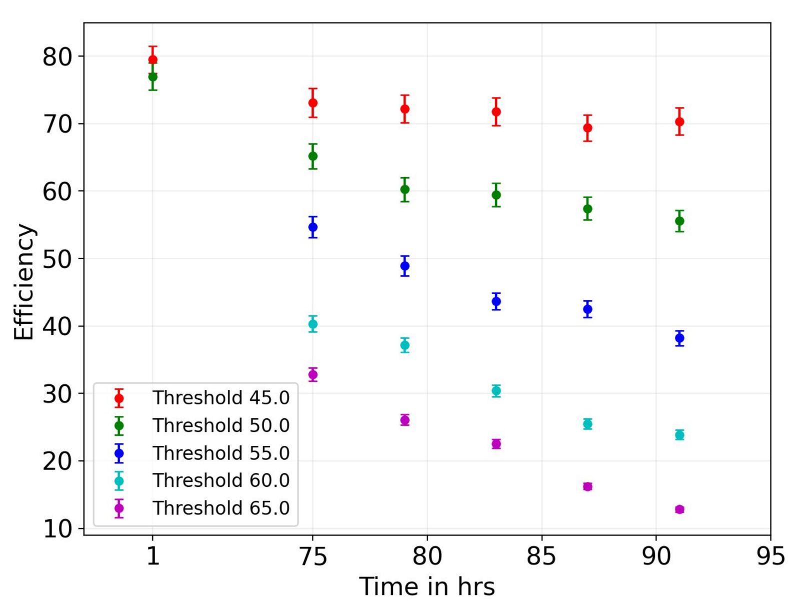


Filters

The following filters are applied to reduce noise [3]

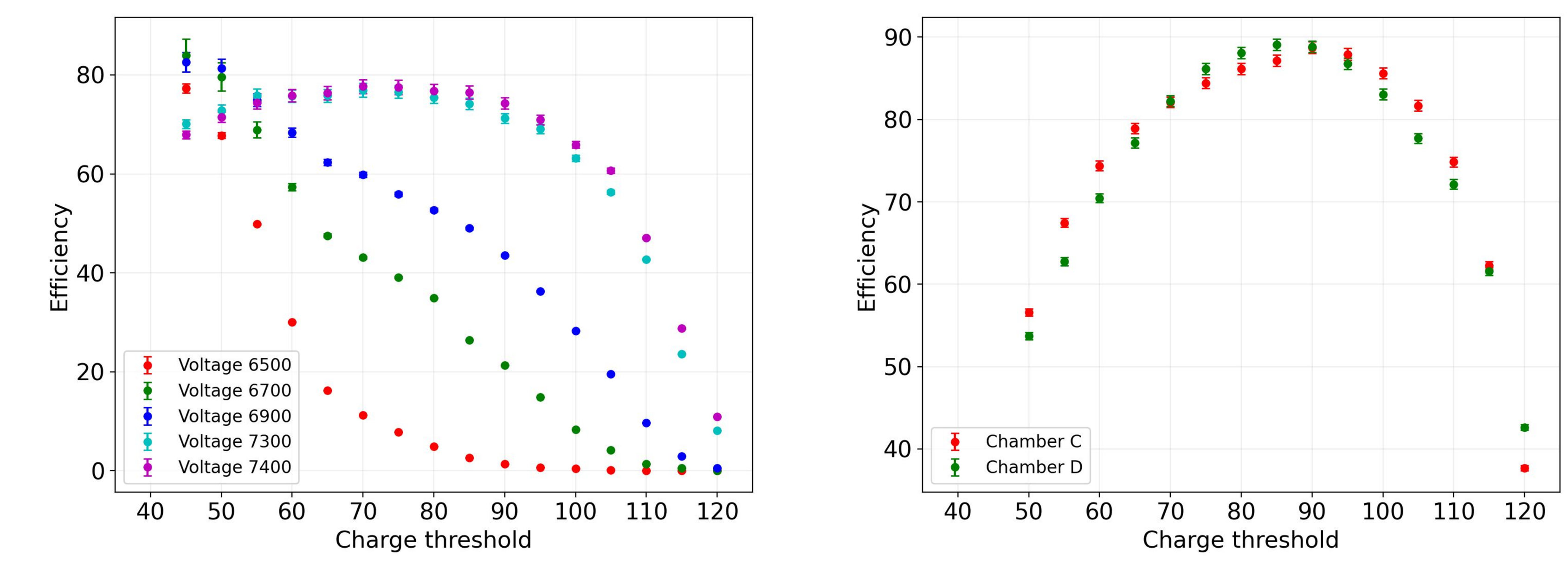
- Time filter by data collection within 15 ns range
- Strip multiplicity <= 2
- Hit clusters per trigger = 1

Reduction in efficiency due to gas leak

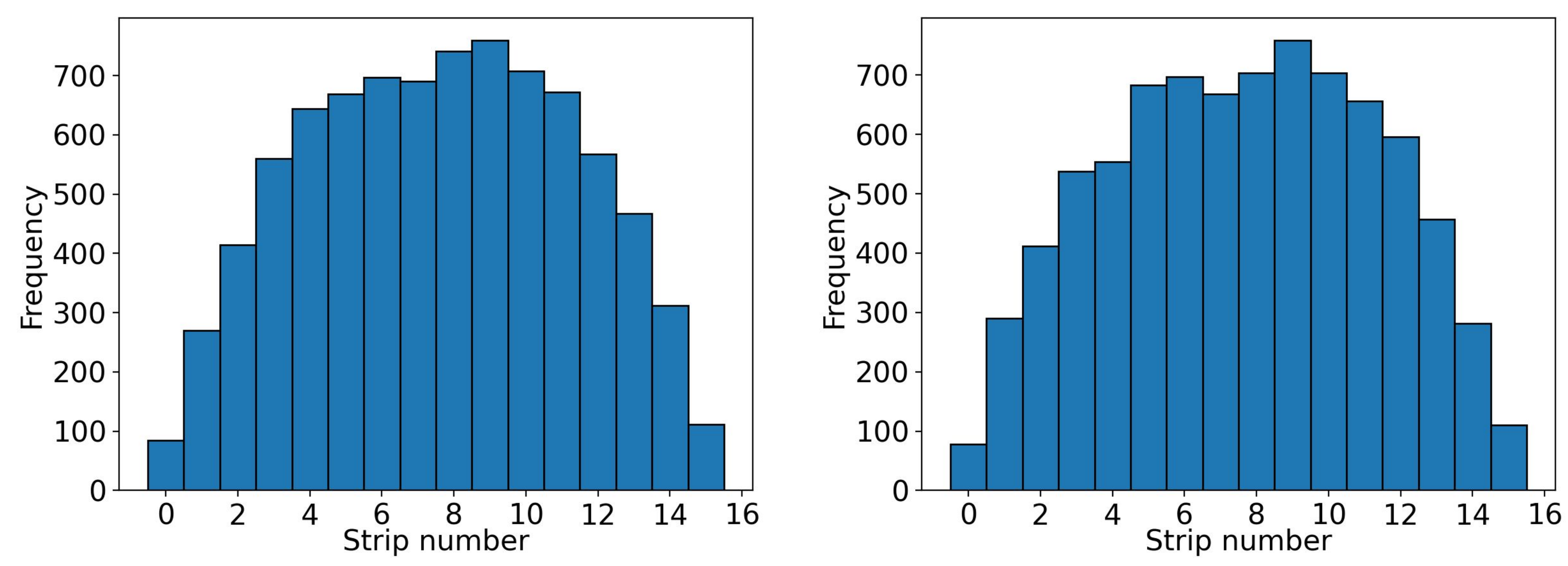


The gain comes back on re-flushing the chamber with fresh gas and fixing the leak

Detector optimization

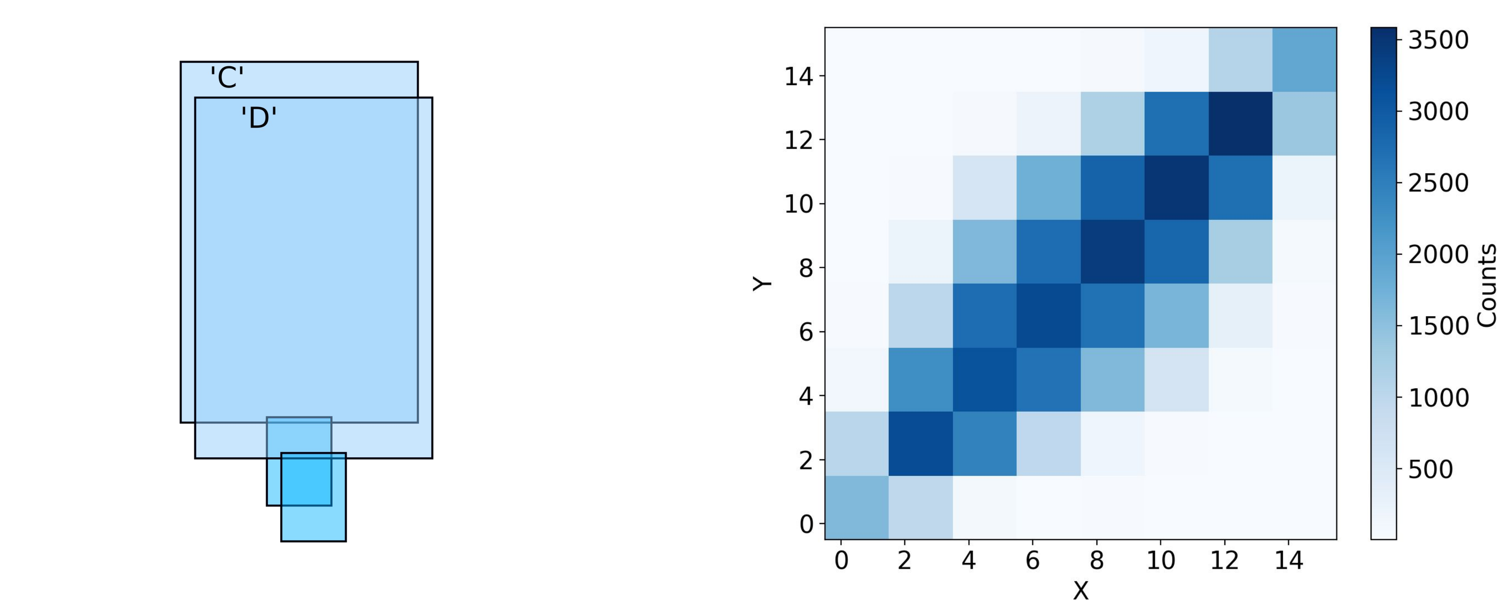


Efficiency behaviour after filter with gain — A well optimized configuration

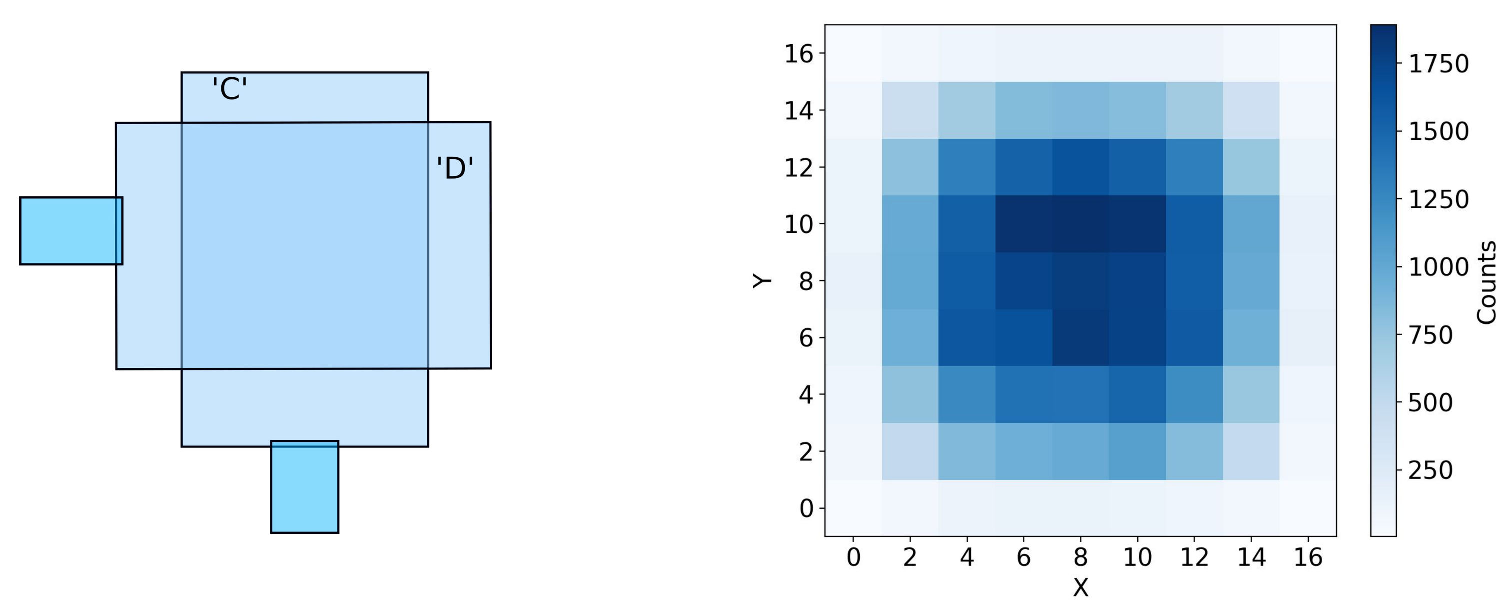


Strip occupancy for chamber 'C' and 'D' respectively for 90 threshold

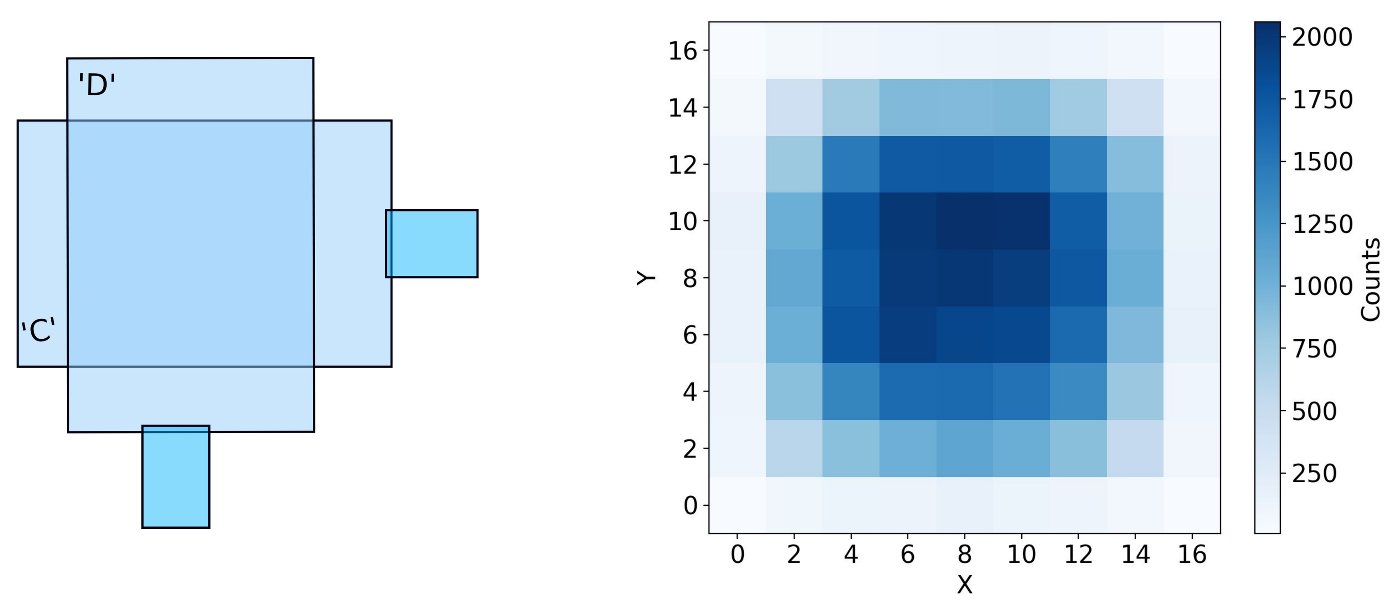
Hit Maps at various configurations



Hit position from setup used for efficiency measurement



Setup to get 2D position information of cosmic muons



Confirming that the observed asymmetry is not due to detector response features but to the actual material distribution around the setup.

Acknowledgments

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References

[1] L. Bonechi *et al.*, Reviews in Physics 5 (2020) 100038.
[2] Marwa Moussawi *et al.*, Proceeding of Science, Muon4Future2023 **452** (2024).
[3] V. Kumar *et al.*, 2024 JINST **19** C04027