FOUR-GAP PHENOLIC RPC'S TEST RESULT WITH COSMIC MUONS AND HIGH-RATE GAMMAS

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ABSTRACT

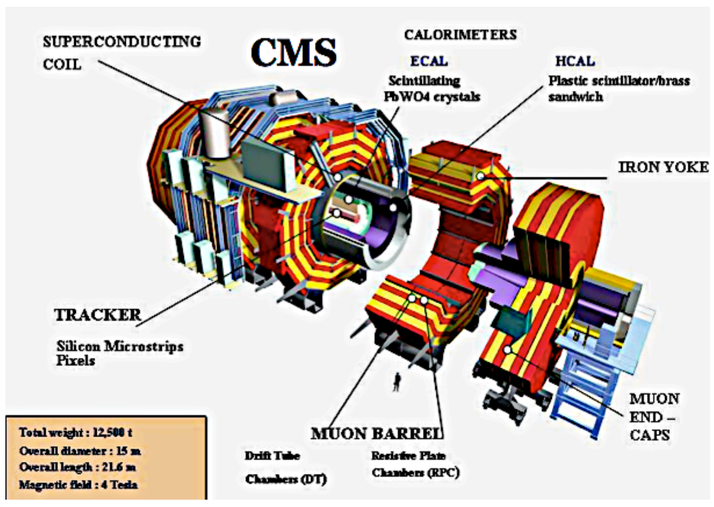
❖ Development of an oiled four gap Phenolic RPC for use as high-rate particle trigger in high energy physics experiments.

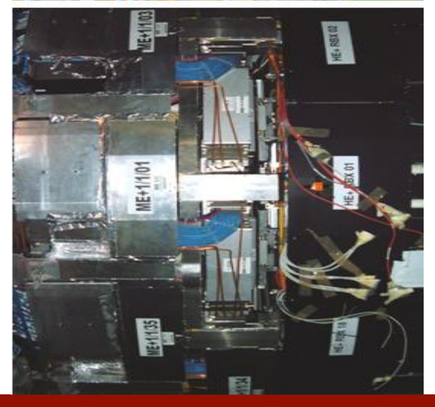
INTRODUCTION

- ✧ Prototype RPC with 4 gaps made from HPL plates has been built.
- ✧ Detector aims at reducing probability of radiation induced degradation &
- ✧ Improvement of the detection rate capability.
- ✧ Properties obtained using muons & gammas from a 200-mCi ^{137}Cs source

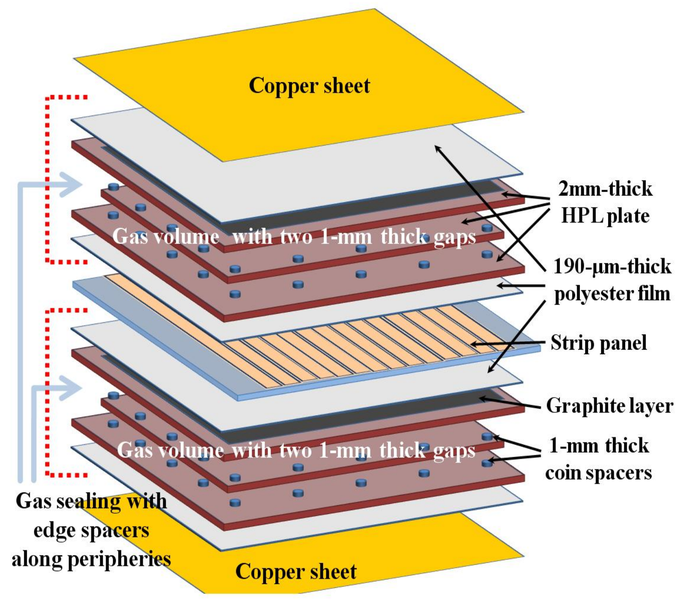
MOTIVATION

- ❖ R & D to develop Panel-type multigap RPC using:
  - ➢ Oiled phenolic HPL resistive plates
  - ➢ 95% Freon & 5% Iso-Butane Gas Mixture.
- ❖ With high η covering: 0.9 < |η| < 2.1

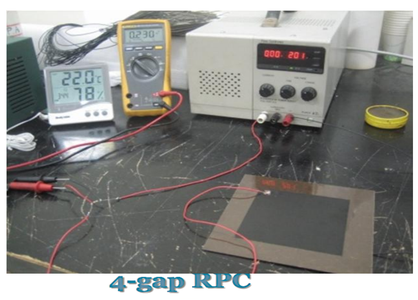




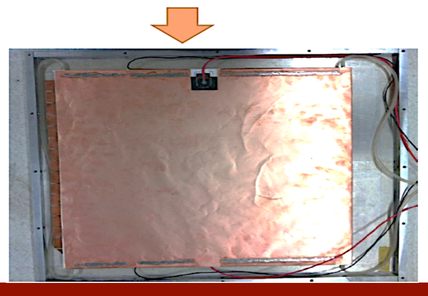
PROTOTYPE PANEL-SHAPE 4-GAP RPC FABRICATION



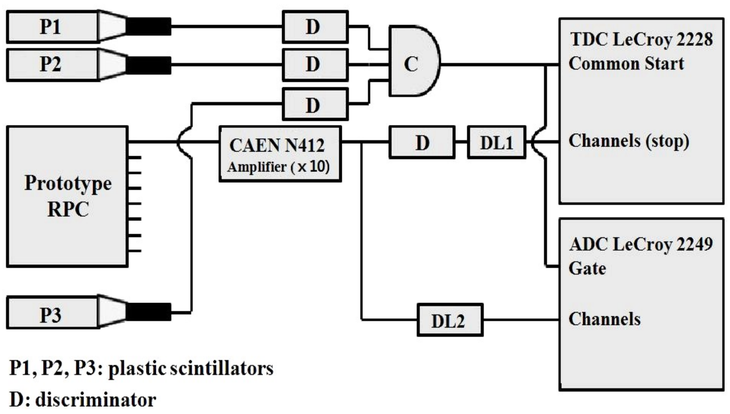
Resistivity, ρ ~ 5.0 x10^{10} Ωcm at 20°C



4-gap RPC



ELECTRONICS SETUP



P1, P2, P3: plastic scintillators
D: discriminator
C: coincidence logic unit
DL1, DL2: delays

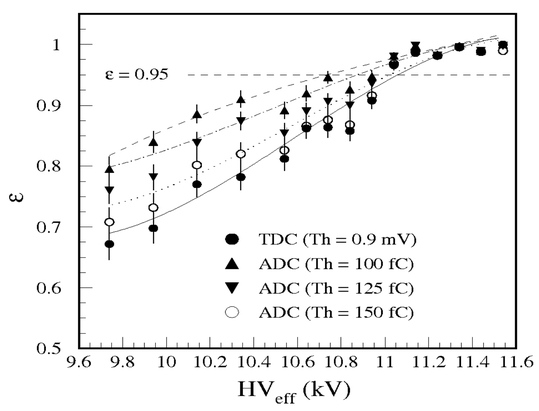
- ⌘ TDC stops' threshold = 9mV.
- ⌘ ADC threshold in offline mode.
- ⌘ Scintillator signals' voltage thr eshold = 30mV.
- ⌘ Noise data & γ-rays obtained by 1kHz clock trigger using 2G Hz pulse generator

- ◎ Gate width for avalanche pulses (FWHM < 10ns) = 40ns.
- ◎ Accuracy for avalanche charge f or each event = 20~ 60fC.
- ◎ Triggers->3 plastic scintillators; time resolution~500ps.

TEST RESULTS

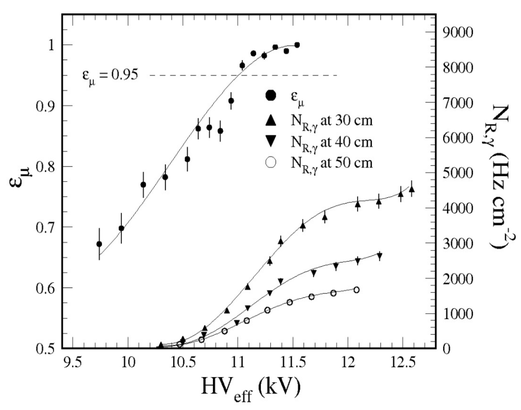
(1) Test with Cosmic Muons

Muon Efficiencies

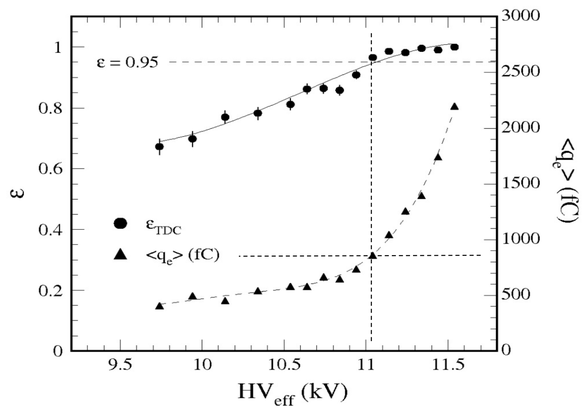


(2) Test with High-Rate Y's

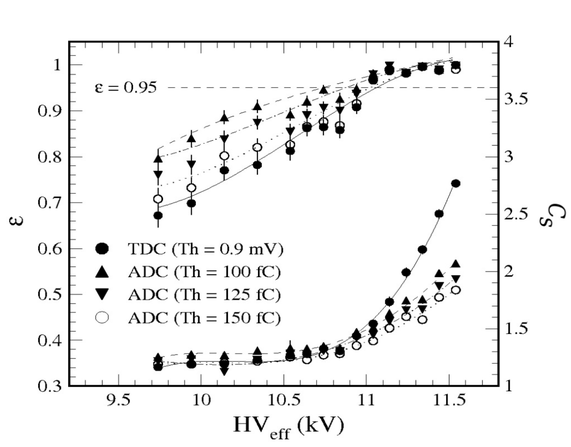
Gamma rates



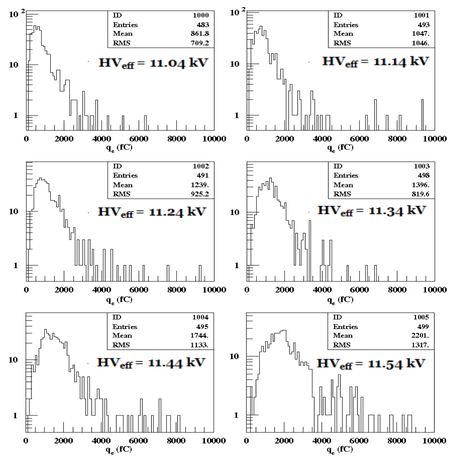
Efficiencies & mean charges of muons



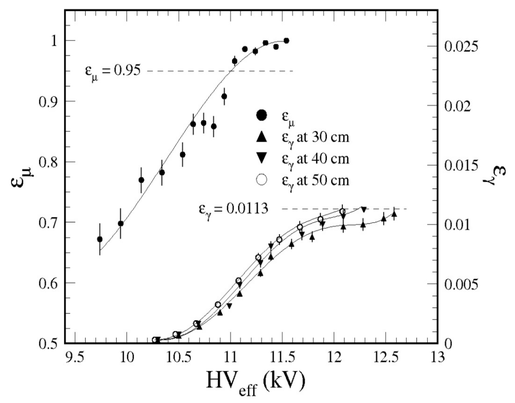
Efficiencies & mean cluster sizes



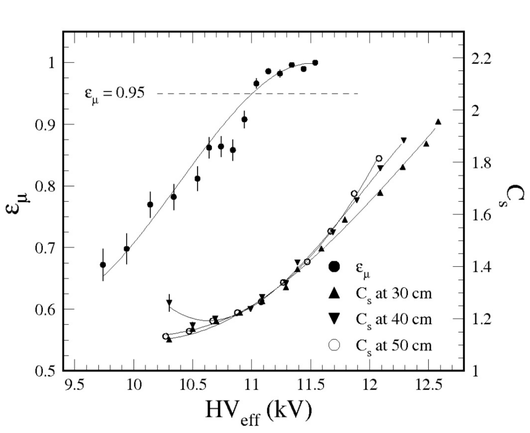
Muon charge distributions



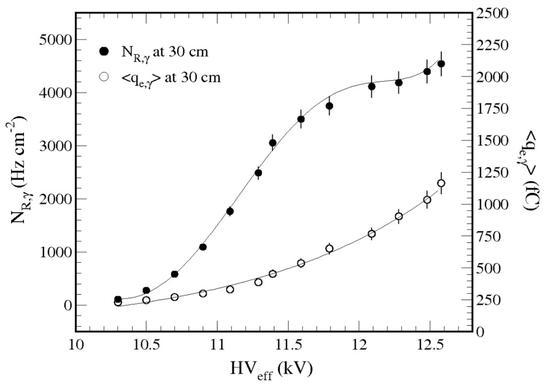
Muon and gamma efficiencies



Mean cluster size



Gamma rate & mean charge



2- & 4-GAP RPC COMPARISON

	2-gap RPCs♪	4-gap RPCs♪
Gap thickness♪	2.0 mm♪	1.0 mm♪
Total gap thickness♪	4.0 mm♪	4.0 mm♪
$<q_e>$avalanche mode♪	2.5 ~ 7 pC♪	1.2 ~ 2.5 pC♪
$<q_e>$at 200V> $HV_{95\%}$♪	4.0 pC♪	1.4 pC♪
Type of HPL♪	Phenol+Mel♪	Phenol+Mel♪
Thickness of HPLs♪	2.0 mm♪	2.0 mm♪
Resistivity of HPLs♪	1 ~ 5 x10^{10} Ωcm♪	~ 1x10^{10} Ωcm♪
Rate capability♪	< 2.0 kHz cm^{-2}♪	> 3.0 kHz cm^{-2}♪

SUMMARY

- ❑ 4-gap RPC fabricated with similar tech. as 2-gap RPCs used in CMS.
- ❑ Size of muon efficiency plateau ≥ 600V for 4-gap RPCs.
- ❑ At 200V above $HV_{0.95}$, $<q_e>$ ~1.25pC with threshold ~150fC.
- ❑ HV shifts~ 500V at N_γ = 4.5 kHz cm^{-2} with ρ = 5.0 x10^{10} Ωcm
- ❑ No degradation found at N_γ = 4.5 kHz cm^{-2}
- ❑ Aging issue:$<q_e>$ ~1/3 of 2-mm double gap RPCs.

MILESTONES

- ✧ QA based R&D for the 4-gap RPC manufacture procedure and parts.
- ✧ Real-size prototype 4-gap RPCs in the high-η regions (RE1/1, RE2/1, RE3) could be used.

REFERENCE

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③ H.C. Kim et al>, Quantitative aging study with intense irradiation tests for the CMS forward RPCs, Nucl. Instrum. Meth. A 533 (2009) 102.

④ M. Abrescia et al., Study of long-term performance of CMS RPC under irradiation at the CERN GIF, Nucl. Instrum. Meth. A 533 (2004) 102.

⑤ S. H. Ahn et al., Characteristics of a double gap resistive plate chamber for the endcap region of CMS/LHC: data vs simulation in avalanche mode, Nucl. Instrum. Meth. A 533 (2004) 32.

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