中国物理学会高能物理分会第十一届全国会员代表大会暨学术年会
2022.8.8-2022.8.11

Performance study of large-area glass resistive plate chambers with different spacer configurations

L. Mao[a], F. Lagarde[a], J. Guo[a] , X. Wang[a], J. Li[a], Q. Shen[a], J. Zhu[a], H. Yang[a,b]

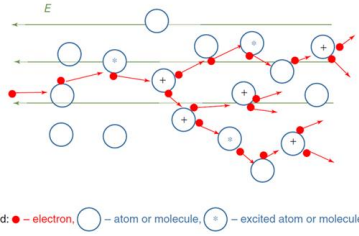
[a]Institute of Nuclear and Particle Physics, School of Physics and Astronomy, Shanghai Jiao Tong University Key Laboratory for Particle Physics, Astrophysics and Cosmology (Ministry of Education) Shanghai Key Laboratory for Particle Physics and Cosmology 800 Dongchuan Road, Shanghai, 200240, P.R. China
[b]Tsung-Dao Lee Institute, Shanghai Jiao Tong University, Shanghai, 200240, P.R. China

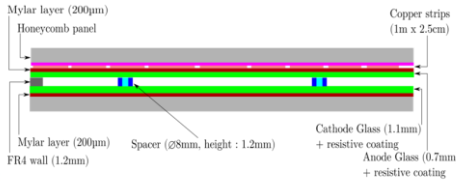
Introduction & Motivation

- RPC(Resistive Plate Chamber) is a gaseous detector based on avalanche mode.
- Which uses resistive material(glass, Bakelite) as electrodes.
- Advantages: Efficiency>95%, time resolution ~1 ns(single gap)[1] ,easy to build, large area, quite cheap.

■ Spacers in RPC gas gap:
- ◆ Maintaining the thickness of gas gap
- ◆ Affecting the gas flow
- ◆ Increasing construction process and cost

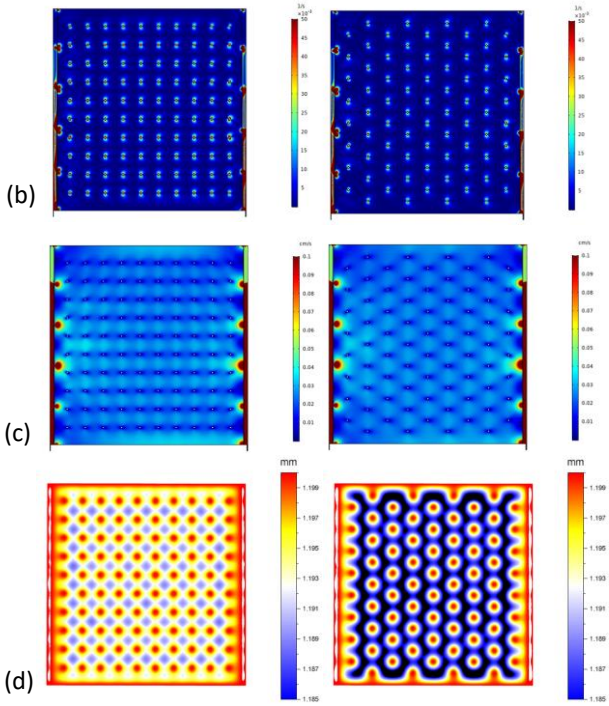
Aim: optimize the configuration of spacers

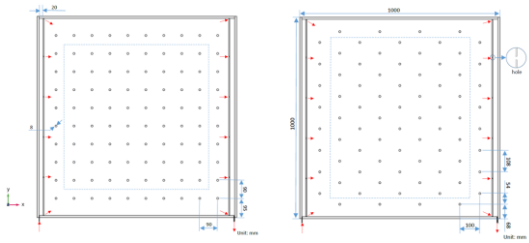




Multiphysics simulation

COMSOL Multiphysics® [2]is used to simulate the gas flow velocity, gas flow vorticity and deformation on the electrodes.



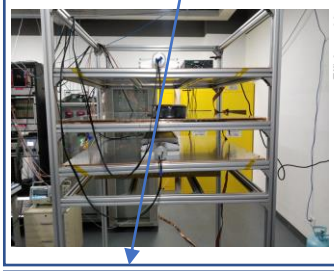


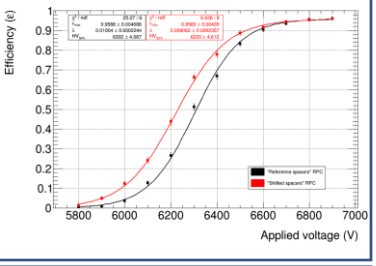
(a) Two gas gap models: “reference spacers” & “shifted spacers”
(b) Velocity distribution of the gas flow
(c) Vorticity distribution of the gas flow
(d) Deformation map of the thickness of gas gap

Model	“Reference spacers” RPC	“Shifted spacers” RPC
Mean velocity $\bar{v}$	0.238 (mm s^{-1})	0.241 (mm s^{-1})
RMS of velocity σ_v	0.049 (mm s^{-1})	0.042 (mm s^{-1})
$\sigma_v/\bar{v}$	20.3 (%)	17.5 (%)
Mean vorticity near spacers region	0.0199 (s^{-1})	0.0196 (s^{-1})
RMS of vorticity near spacers region	0.0129 (s^{-1})	0.0127 (s^{-1})
Mean vorticity excluding the vicinity of spacers	0.0022 (s^{-1})	0.0018 (s^{-1})
RMS of vorticity excluding the vicinity of spacers	0.0028 (s^{-1})	0.0026 (s^{-1})
Mean thickness between gas gap $\bar{d}$	1.193 (mm)	1.189 (mm)
RMS of deformation σ_d	0.003 (mm)	0.005 (mm)
$\sigma_d/\bar{d}$	0.25 (%)	0.42 (%)

Test under cosmic ray

The test setup and the final efficiency curve versus applied voltage.





Conclusions

By shifting the spacers, then increase the distance
(1) Decrease the spacer number(100 → 76), a 24% decrease
(2) More active region($1-\frac{spaces'space}{chamber's\ space}$), 99.487% to 99.610%.
(3) Making the gas to move more uniformly
(4) Lower vorticity inside the chamber
(5) Maintaining similar deformation uniformity of the electrodes

Reference

[1] G. Aielli et al. *Studies on fast triggering and high precision tracking with Resistive Plate Chambers.* doi:10.1016/j.nima.2013.02.044.
[2] COMSOL AB. COMSOL Multiphysics®, URL www.comsol.com.