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Realistic simulation of the MPD Time Projection Chamber with Garfield++

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Schematic illustration of the working principle and the read-out chambers of the TPC



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Thank you to ALICE for original image

TPC important parameters

Gas composition: Ar 90% + CH₄ 10%

Temperature: 293.15 K (20° C) *Pressure : Atmospheric + 2 mbar* Magnetic field: 0.5 Tesla **Electric field : 140 V/cm** Drift length : 163 cm HV electrode voltage : -23 kV Gating grid voltage : -42.5 V (opened) -42.5 V ± 100 V (closed) Shielding grid (anode) voltage : 0 V Sensing grid (cathode) voltage : 1400 V

MPD TPC Read Out Chamber (ROC)



Garfield++ software



a toolkit for the detailed simulation of detectors which use gases or semi-conductors as sensitive medium

Ionization calculation by **HEED** program

Electric fields calculations with different mathematical techniques

Transport and avalanches of electrons by Magboltz program

Values obtained by Garfield++

Electrons drift velocity : 5.538 cm/\mus ± 0.018%

Longitudinal diffusion : 0.0347 cm^{1/2} ± 2.5%

Transverse diffusion : 0.0228 cm^{1/2} ± 3.2%



Gating grid voltage : -42.5 V (-/+100 V for closed gate)

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10 ions+ drift simulation



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10 000 ions+ drift simulation



Induced current with different gate voltage



SAMPA-electronics response 2.5 signal [mV] $f(x) = A\left(\frac{x-t}{\tau}\right)^{N} e^{-N\left(\frac{x-t}{\tau}\right)}$ N = 4 $\tau = 160$ 2 A = 20 mV/fC1.5 0.5 0 500 1500 2000 1000 0 14/16time [ns]

Conclusion

Updated basic parameters of electrons drifting

Simulated for ROC chambers:

field maps e⁻ / ion⁺ drift paths signal on ROC pad plane for different gate voltages electronic response for signal on ROC pad plane

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THANK YOU FOR YOUR ATTENTION