Contribution ID: **42** Type: **Plenary Talk**

Garfield simulation to study the improvement of time response of RPC in different configurations

Thursday, 22 February 2018 17:40 (20 minutes)

The proposed ICAL detector [1] at India-based Neutrino Observatory will use Resistive Plate Chambers (RPC) [2], stacked in 150 layers with iron plates sandwiched between them, as the tracking device for the muons created by the atmospheric neutrinos through their charged current interaction with the iron nuclei. Fast and efficient measurement from each RPC layer is an important factor for this kind of set-up, which will help to properly tag the events as well as distinguish up-going muon tracks from the down-going ones.
The detection efficiency and timing performance of RPC depends on proper signal generation within the detector which is critically dependent on the device geometry, used gas mixture as well as on the applied voltage. A Multi-gap RPC (MRPC) [3], having more than one gas gap with smaller gap width is popular for its very good time resolution (~50 ps) compared to a single gap RPC (~2 ns) and is used as a trigger device in many experiments and also for Time-of- Flight measurements.
In the present work, numerical calculations have been performed to get an insight on the working principle of RPCs and MRPCs and the results have been compared to available experimental data to establish the efficacy of the simulation framework. Garfield simulation framework [4] has been used to perform the calculations. The calculation of time response of an RPC [5] has been extended here to a standard MRPC geometry. First, the dependence of average signal amplitude and the timing parameters on the gap width of a RPC has been found out. Then the effect of the increase in the number of gas gaps on signal amplitude as well as timing parameters has been calculated. Finally, the time response of a standard 6-gap MRPC geometry has been calculated at different operating conditions and compared with available experimental data.

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Session Classification: Simulations and Modeling