A New cluster-based CbmRoot reconstruction chain for the TRD

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A new track position reconstruction chain with a realistic cluster charge induction algorithm was implemented in CbmRoot. This algorithm is based on the induced charge distribution described by Mathieson [1] and implemeted for rectangular pad geometries. The full chain consists of three classes; CbmTrdClusterizer, CbmTrdClusterFinderFast and CbmTrdHitProducerCluster.

CbmTrdClusterizer

The Clusterizer is used to aproximate the induced charge on the pad plane created by the primary MC-particle. To describe this charge distribution, one needs only one parameter $K3$, which is a function of characteristic chamber parameters. Let $\rho(r)$ represent the induced charge density distribution on the cathode pad plane in a chamber with equal distance of the cathode planes with respect to the anode wire plane. The x-coordinate can either be parallel or normal to the anode wire direction. One can write the formula for two dimensions with $r = \sqrt{x^2 + y^2}$ and a given net anode charge q_a:

$$\rho\left(r/h\right) = q_a \cdot \frac{\pi/2\cdot\left(1-\sqrt{K_3}/2\right)\sqrt{K_3}}{4\arctan\left(\sqrt{K_3}\right)} \cdot \frac{1-\tanh^2\left(\pi/2\cdot\left(1-\sqrt{K_3}/2\right)r/h\right)}{1+K_3\tanh^2\left(\pi/2\cdot\left(1-\sqrt{K_3}/2\right)r/h\right)}$$

Values of $K3$ have been taken from [1]. The algorithm implemented in CbmRoot has a static $K3$ value of 0.525 which corresponds to an anode wire radius of 25 μm, an anode-cathode separation of 3 mm and an anode wire pitch of 3 mm. This fixed value can be replaced by a parameterization to cope with variable detector geometries. The Mathieson-formula is calculated along the particle track at periodical positions which provide for MC-particles with a large impact angle. The induced charge is given by the integral of the charge density on the pad plane. The information of each fired pad is stored in a so called TrdDigi.

CbmTrdClusterFinderFast

The CbmTrdClusterFinderFast re-sorts the chronological TrdDigis into spatial order and associates TrdDigi accumulations with TrdClusters. This is done by using the so called combiID. This ID provides the combined row and column information of each pad by a unique number within each module. They get a spatial order by sorting the TrdDigis by the combiID. TrdDigis with a continuous combiID are combined to rowClusters, row by row. Rows are seperaed by a artificial dummy column. Subsequently, overlapping rowClusters in consecutive rows are merged to final TrdClusters. The merging step is skipped for chambers within a certain radius around the beam pipe, since the probability for row overlapping TrdClusters is correlated to the impact angle and the path length of the particle track through the chamber volume. The TrdClusters are CbmRoot data objects like TrdDigis. Due to the high hit density, especially for the detectors close to the beam pipe, a separation mechanism for neighbouring TrdClusters was implemented. This is realised by a minimum charge threshold for TrdDigis which has been optimized.

CbmTrdHitProducerCluster

The CbmTrdHitProducerCluster is used to reconstruct particle positions from TrdCluster information provided by the CbmTrdClusterFinderFast. The Hitproducer use the charge information of each TrdDigi within the TrdClusters. First, the TrdDigi with the maximum charge per TrdCluster is searched. From this information the TrdHit position is reconstructed by applying a center-of-gravity method.

Conclusion

After optimizations of the method MC simulations yield an overall reconstruction efficiency between 75% and 90%. The position resolution along the wire direction is around 300 microns averaged over all hits in the TRD (see Fig.1) which meets the technical design goal of 300 - 500 microns for the CBM TRD.

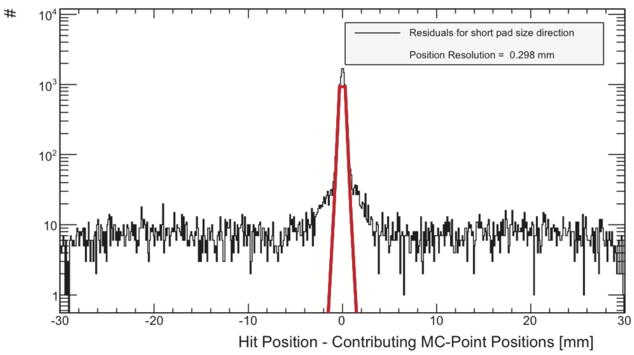

Figure 1: Position resolution of the reconstructed hits relativ to the MC-positions for short pad size direction

References

[1] E. Mathieson, Nucl. Instrum. Meth. **A 270** (1988) 602