Identification of electron tracks using the correlation between PMD and FTPC in the STAR experiment at RHIC

Prithwish Tribeby
(For the STAR Collaboration)
VECC, Kolkata, INDIA

Introduction
We present a method based on correlating the clusters from the Photon Multiplicity detector (PMD) and the tracks from the Forward Time Projection Chamber (FTPC) for identifying electron tracks. PMD is a preshower detector covering forward region at STAR which has overlap with East FTPC (common $\eta = -2.8$ to -3.7) and generates clusters with higher energy deposition for electrons compared to charged hadrons [1]. We have utilized this property by constructing a 2D correlation function $(\eta - \phi)$ between PMD clusters and FTPC tracks. The application of a large threshold on PMD clusters correlated to FTPC tracks helps removing charged hadron candidates and an enriched sample of electron can be obtained.

Method and Results
A 2-d correlation plot shown in Fig.1 is obtained by measuring $\Delta \eta (\eta_{\text{track}} - \eta_{\text{pmd-cluster}})$ and $\Delta \phi$ between FTPC tracks and PMD clusters. The quality criteria used for FTPC tracks are, DCA<$3cm$, $0.1 < p_T < 1.5$ GeV/c, and no. of fit points $>5$. A clear peak is seen around $\Delta \eta = 0$, and $\Delta \phi = 0$ showing FTPC tracks correlated to PMD clusters. Other than electron tracks and matching clusters the possibilities of origin of the peak could be from (a) jets (b) low $p_T$ particles originating from the domains of Disoriented Chiral Condensate (DCC) and (c) charged-hadrons forming clusters in the PMD after interaction. The first possibility can be eliminated due to narrow width of the peak and absence of away-side peak. For DCC, $p_T$ should be even lower.

In order to eliminate the charged hadrons, we apply a threshold on PMD clusters of $n \times \text{MIP}$ (Minimum ionizing particle) where we chose $n > 3$ and varied $n$ to study the effect. We have performed a detailed analysis of the one-dimensional correlation function ($\phi$-plane). The signal strength is defined as the area under the background subtracted peak $= \frac{\text{Sig-Bkg}}{\text{Bkg}}$. We have studied the variation of the signal strength with MIP-cut. It is expected that for tracks from charged hadrons correlated to PMD-clusters, signal strength should decrease with increasing MIP cut.

Fig.2 shows the variation of the signal strength with $n \times \text{MIP cut}$. We find an
FIG. 2: Variation of signal strength with MIP cut

FIG. 3: Variation of the signal strength for single particle GEANT simulation

increasing trend contrary to expectation for charged hadrons. This suggests that the candidates might be rich with electrons or positrons.

We have performed simulation to pinpoint the origin and found a similar peak from HIJING[2] ruling out the possibilities of DCC. We have done single particle GEANT simulation for $e^+$ and $\pi^+$ separately and studied the variation of the signal strength with MIP. While for $\pi^+$ the signal strength decreases (Fig.3), electron sample shows an increasing behaviour similar to the data suggesting the correlation is due to electrons.

As a final step, we calculate the invariant mass of pairs of $e^− - e^+$ candidates. These candidates are chosen from the peak region applying criteria of detection of electrons as correlated track and cluster with $\Delta \eta < 0.1$, $\Delta \phi < 0.35$ rad, PMD MIP cut $> 20$, PMD nCell $> 1$ and FTPC $0.1 < p_T < 1.5$ GeV. The invariant mass analysis was done for both real and mixed events for the CuCu $\sqrt{s_{NN}} = 200$ GeV data set.

Conclusion

For CuCu collisions data at $\sqrt{s_{NN}} = 200$ GeV from STAR we find that the invariant mass (M_{inv}) distribution (Fig.4) for such electron-positron pairs (with $p_T < 0.3$ GeV for each particle) peaks at $\sim 2$ MeV with a width of $\sim 20$ MeV confirming that they are indeed coming from conversion of photons. Using this technique of electron identification we can also calculate invariant mass for $e^+e^−$ pairs which are decay product of mesons.

References