第 1 章　Analysis

1.1　Data set and event selection

The data set used in this analysis was minimum bias triggered event taken in year 2010 and year 2011 Au+Au 200 GeV collisions and central triggered date taken in year 2010 Au+Au 200 GeV collisions. For the p+p analysis, the data set was taken in year 2012 p+p 200 GeV minimum bias collision. The minimum bias trigger was defined as a coincidence in the east and west VPD detectors, and an online vertex cut was applied to select the collision happening in the center of the detector. For the central trigger, a small signal in the ZDC detectors was required as well as a large multiplicity from the barrel TOF. This trigger corresponds to 0-10% of the total hadronic cross section.

Events used in this analysis were selection by the following event selection criteria. To insure the TPC performance, events were required to have a valid reconstructed collision vertex (primary vertex, defined by primary tracks) within 30cm (for Au+Au 200 GeV collisions, Figure 1.1 (c)) and 50cm (for p+p 200 GeV collisions) of the TPC center alone the beam pipe (z direction). Figure 1.1 (b) shows correlation between TPC vertexZ and VPD vertexZ. The clean diagonal correlation band indicate the correct vertices which fire the VPDMB trigger. Random distributions could also be see in a wide region which typically indicate the vertex found be TPC is a pile-up vertex (the wrong vertex from different bunch crossing collisions). The cross like distribution in the random correlation regions is due to the online vertexZ cut in the trigger definition.To suppress the pile up events and to ensure that the selected event is firing the trigger, the difference between event vertex z-coordinate (V_z) and the V_z calculated from the VPD timing was required to be within 3cm (for Au+Au 200 GeV collisions) and 6cm (for p+p 200GeV collisions). In order to remove the events from the Au beam hitting the Beam pipe, 2cm of the vertex radius cut was also applied in the data selection. The vertex criteria is also shown in table 1.1. The events number after event selection is shown in table 1.2.

1.2　Centrality definition

The centrality in Au+Au 200 GeV collisions was defined using the uncorrected charged particle multiplicity $dN/d\eta$ within $|\eta| < 0.5$ (also called reference multiplicity). A Monte Carlo Clauber calculation was used to compared with the $dN/d\eta$

Au+Au 200 GeV	p+p 200 GeV
First primary vertex	
ranking > 0	ranking > 0
$\|Vr\| < 2cm$	
$\|Vz\| < 30cm$	$\|Vz\| < 50cm$
$\|Vz - VzVpd\| < 3cm$	$\|Vz - VzVpd\| < 6cm$

Table 1.1 vertex selection criteria.

Year	Run Type	# of events
2010	Au+Au 200 GeV MinBias	240M
	Au+Au 200 GeV Central	220M
2011	Au+Au 200 GeV MinBias	490M
2012	p+p 200 GeV MinBias	375M

Table 1.2 Number of events after event selection.

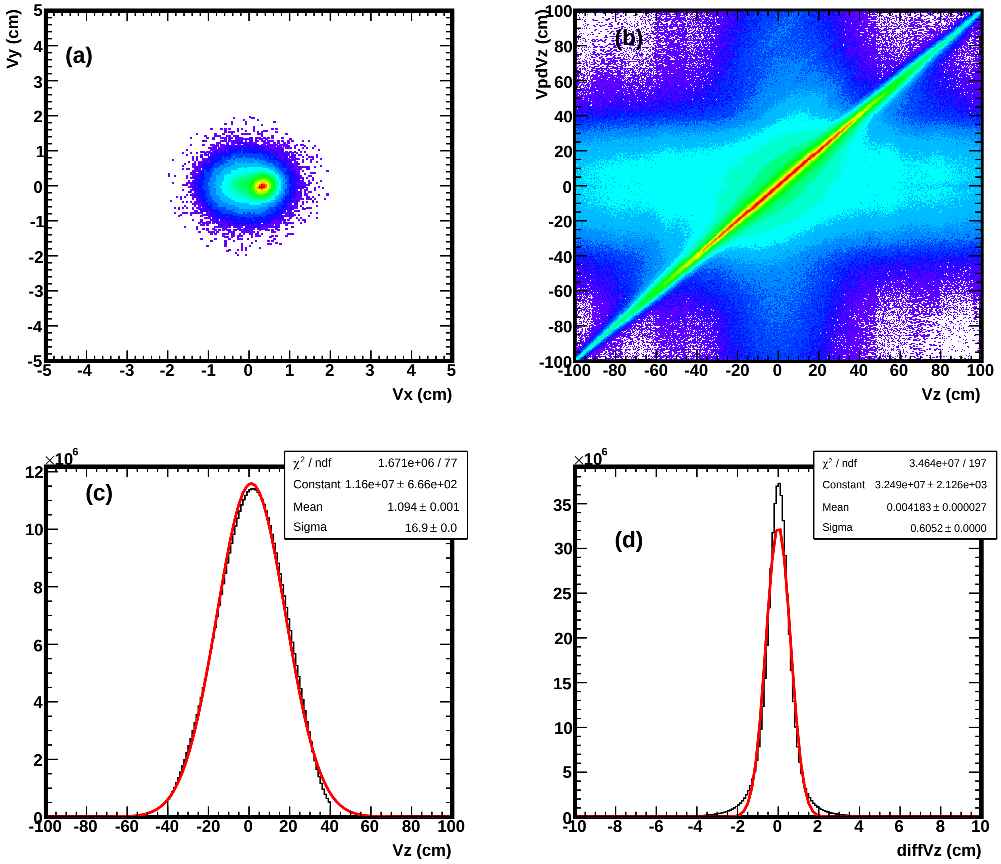

Figure 1.1 (a) TPC vertexR distribution, (b) TPC vertexZ and the VPD vertexZ correlation, (c) TPC primary vertexX distribution, (d) difference between TPC vertexZ and the VPD vertexZ in Au +Au 200 GeV minimum bias collisions.

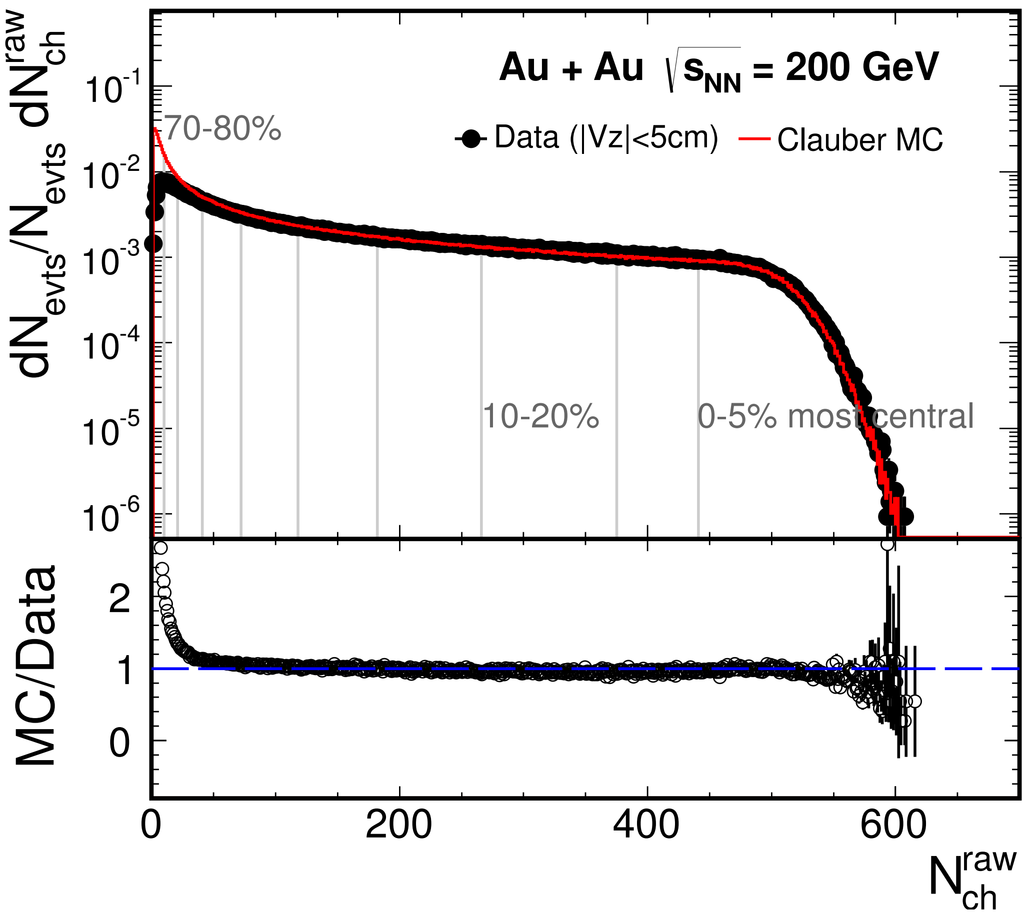

Figure 1.2 Upper Panel: Uncorrected charge particle multiplicity distribution measured within $|\eta| < 0.5$ and $|Vz| < 5cm$. The red curve represents the multiplicity distribution from MC Glauber calculation. Bottom Panel: the ratio between MC and data.

distribution from data to define centrality bins. The dependence on collision vertex Z-position and the luminosity has been also taken in account to address the efficiency and acceptance change on the measured $dN/d\eta$. Figure 1.2 shows the uncorrected $dN/d\eta$ distribution measured within $|Vz| < 5cm$ and extrapolated to zero ZDC coincidence rate for the VPDMB triggered events for Au+Au 200 GeV collision in year 2010 as well as the MC Glauber simulation. The discrepancy at the low multiplicity is because the VPD trigger efficiency starts getting lower while fewer particles are produced. The difference in low multiplicity region has been taken as a weight with the ration shown in Fig. 1.2 (bottom panel) to account for the VPD inefficiency. Finally, the centrality bins are defined according to the MC Glauder distribution to determine the cut on the measured multiplicity.

1.3 Track selection and electron identification

1.3.1 Track selection

Electron candidates are selected from good tracks satisfied the flowing selection:

1. number of fit points (*nHitsFit*) in the TPC greater than 20 (maximum 45) to ensure good tracking quality and momentum resolution;
2. the ratio of number of fit points over number of possible fit points in TPC greater than 0.52 to avoid split tracks in the TPC;
3. distance of closet approach (*dca*) to the primary vertex less then 1 cm to make sure selected tracks are from the primary collision;
4. number of *dE/dx* points used for calculation average *dE/dx* greater than 15 to ensure good *dE/dx* resolution.
5. with a valid matching to a TOF hit and projected position on TOF module with the sensitive readout volume.

1.3.2 Electron identification

In additional of track detection, momentum determination, TPC also provide particle identification for charged particles by measuring their ionization energy loss (*dE/dx*) in the TPC gas. With TPC only, however, it is difficult to separate electron from hadrons because the electron band crosses with hadron bands in higher momentum. With the flight timing information measured by TOF and the track path-length measured from TPC, we can calculate the velocity (β). Due to the very small electron mass, electron can be separated from the slow hadron by the velocity cut. Combining the velocity (β) information from TOF and energy loss(*dE/dx*) from TPC, electron can be identified up to momentum ~3GeV/c.

Track quality cuts		PID cuts	
dca	<1cm	$p_T >$ 0.2GeV/c	> 0.2GeV/c
nHitsFit	>= 20	$n\sigma_e, p < 1.0GeV/c$	$1.5 \times (p-1) - 1.2 \sim 1.6$
nHitsFit/nHitsPoss	>=0.52	$n\sigma_e, p > 1.0GeV/c$	$-1.2 \sim 1.6$
ndEdxFit	>15	TOF $1/\beta$	$\|1-1/\beta\| < 0.025$(for Au+Au)
η	+/- 1		$\|1-1/\beta\| < 0.03$(for p+p)
		TOF yLocal	$\|yLocal\| < 1.8cm$

Table 1.3 Electron selection criteria