Dimuon mass continuum in Pb+Pb collisions at $\sqrt{s}_{NN}$=2.76 TeV

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Introduction

The dilepton invariant mass spectrum measured in heavy ion collisions holds the most promising signatures of the QGP, such as thermal radiation, J/ψ, Ψ' and Υ. The dilepton probe is sensitive to many different sources. In the low mass region, the resonance decays from the light hadrons constitute the main background. In the intermediate and high mass regions, the Drell-Yan dilepton production from the initial hard scattering is important. In high energy heavy ion colliders such as RHIC and LHC, the heavy flavor quark production is quite substantial and their subsequent decays in semileptonic channels can add a large contribution to the continuum in the invariant mass spectrum of dileptons. Thus, understanding the physics of heavy meson production and their decays is very important to get reliable signals of QGP and it is still an open and active area of research in physics[1–4]. In the present study we estimate contributions from semileptonic decay of B and D mesons in PbPb collisions at 2.76 TeV. These contributions are then compared to thr Drell-Yan distribution at same energy. Their relative contribution have been studied in different kinematical ranges relevant for detectros used at LHC.

Dimuon production at LHC energies from open charm, open beauty and Drell-Yan decay

We used NLO perturbative QCD distributions for charm and beauty quarks. These quarks are then fragmented using PYTHIA [5]. Thus giving one B $\bar{B}$ (D $\bar{D}$) pair in every event. Then B $\bar{B}$ (D $\bar{D}$) are forced to decay in semileptonic channel simultaneously (B$\rightarrow \mu + X(10.3\%)$, D$\rightarrow \mu + X(17.6\%)$) This gives one correlated muon pair in each event. Dimuon invariant mass is constructed using these muons and compared with Drell-Yan distribution at same energy. Effective production cross sections shown in table I are calculated as follows

$$\sigma_{AA}(B\bar{B} \rightarrow \mu^+\mu^-) = \sigma_{pp} \times A^2 \times BR_{(B\bar{B}\rightarrow\mu+X)} \quad (1)$$

$$\sigma_{AA}(D\bar{D} \rightarrow \mu^+\mu^-) = \sigma_{pp} \times A^2 \times BR_{(D\bar{D}\rightarrow\mu+X)} \quad (2)$$

where A is the mass number of Pb.

TABLE I: cross section × branching ratios for charm, beauty and Drell-Yan dimuons up to NLO for Pb Pb

$\sqrt{s_{NN}}$ (TeV)	b b (m barn)	c $\bar{c}$ (m barn)	Drell-Yan (m barn)
5.5	96.3	8597.7	2.813
4.0	60.54	5964	2.349
2.8	41.35	4582.45	1.947

TABLE II: Expected events with various muon kinematical cuts in CMS detector at $\sqrt{s_{NN}} = 2.76$ TeV for $\int$L dt=10(μ b)$^{-1}$.

	Total number	$\lvert\eta^\mu\rvert \leq 2.1$ $p_T \geq$ 2.0 GeV	$\lvert\eta^\mu\rvert \leq 2.1$ $p_T \geq$ 3 GeV
D$\bar{D} \rightarrow \mu^+\mu^-$	4.581×10^7	738	54
B$\bar{B} \rightarrow \mu^+\mu^-$	413451	16367	1886
Drell-Yan	17372	826	347

Darell-Yan cross section is estimated from PYTHIA [5].

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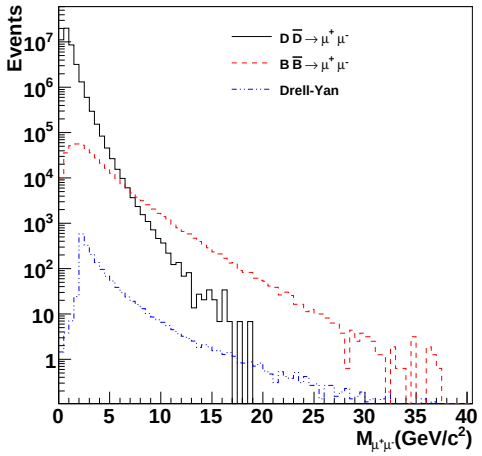

FIG. 1: Relative invariant mass distributions of decay muons from open beauty, open charm and Drell-Yan at $\sqrt{s}_{NN} = 2.76\ TeV$, normalized to $\int Ldt = 10\ (\mu b)^{-1}$

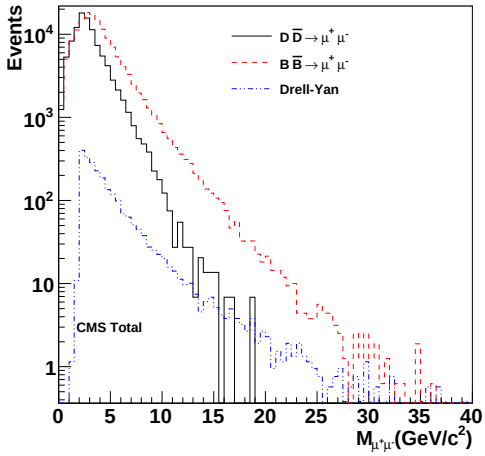

FIG. 2: Relative invariant mass distributions of decay muons from open beauty, open charm and Drell-Yan at $\sqrt{s}_{NN} = 2.76\ TeV$, inside CMS detector($|\eta^\mu| \leq 2.1,\ p_T \geq 1.0GeV$), normalized to $\int Ldt = 10\ (\mu b)^{-1}$

Table II shows expected numbers of dimuons coming from Drell-Yan, B and D meson decay at $\sqrt{s_{NN}} = 2.76$ TeV for $\int Ldt$=10$(\mu$ b$)^{-1}$. Dimuons expected inside CMS acceptance with various p_T cuts on decay muons are also listed in the table. Figure 1 shows realative distributions of dimuons from Drell-Yan and semileptonic decay of B(D) mesons. It can be seen that for $M_{\mu^+\mu^-} \leq 7$ GeV/c^2 dimuons coming from semileptonic decay of D$\bar{D}$ mesons dominates, beyond that dimuons coming from semileptonic decay of B$\bar{B}$ mesons will be the main contribution. Dimuons coming from Drell-Yan decay are over shadowed by dimuons from the semileptonic decay of heavy mesons. Ofcourse this picture does not include energy loss of quarks in medium. Figure 2 shows relative distributions inside CMS detector ($|\eta^\mu| \leq 2.1,\ p_T \geq 1.0GeV/c$). It can be concluded that although open charm production cross section is maximum at LHC but inside CMS detector dimuons coming from the semileptonic decay of B mesons will be the main background for J/ψ and Υ measurements. Also at 2.76 TeV we do not find any contribution of these dimuons for $M_{\mu^+\mu^-} \geq 40$ GeV. So it can be concluded that Z^0 will be clean from these backgrounds. We plan to calculate dileptons coming from thermal radiation of Quark Gluon Plasma and compare them with these dilepton distributions.

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