# Continuum components in dilepton mass spectrum in Pb+Pb collisions at $\sqrt{s}_{NN}$=2.76 TeV

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## Introduction

The heavy ion collisions are performed to study the interaction of matter at extreme temperatures and densities where it is expected to be in the form of Quark Gluon Plasma (QGP), a state where color degrees of freedom are dominant. One of the most striking signal of QGP is the suppression of quarkonium both for charmonia and bottomonia measured through their decays in dilepton channels. The dilepton invariant mass spectrum is also sensitive to many different sources. In the present study, we calculate the production cross section for charm and beauty quark pairs using pQCD up to next to leading order (NLO) and their contributions to dileptons for Pb+Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV. The dileptons coming from QGP and hadron phases are calculated using thermal model and DY using pythia. The relative contribution of different sources have been estimated employing Monte Carlo methods and have been studied in different kinematical ranges relevant for detectors used at LHC.

## Dilepton production from open charm and bottom decays

First we calculate the production cross sections for $c\bar{c}$ and $b\bar{b}$ pairs with pQCD up to next to leading order (NLO) using formalism of Ref [1]. We produce one charm pair in every event as per their $p_T$ and rapidity distributions by Monte Carlo method. Both $D$'s are then forced to decay in semimuonic channel by $D \to \mu + X(17.6\%)$. This gives one correlated muon pair in every event. Dimuon invariant mass is constructed using these muon pairs in the continuum. A similar event sample is produced using bottom quark distributions. The effective production cross sections for charm, bottom are shown in table alog with DY calculated by pythia. The number of muon pairs in Pb+Pb minimum bias collision is calculated using p+p cross section as follows: $N_{PbPb} = \sigma_{pp} \times T_{AA} \times BR^2$ where $T_{AA} = 5.66$ mb$^{-1}$ is the nuclear overlap function calculated for Pb+Pb system using the Glauber model. Drell-Yan cross section is estimated from PYTHIA [2].

TABLE I: Quarkonia, heavy flavour cross sections from NLO calculation and Drell-Yan cross sections from PYTHIA. $N_{q\bar{q}}$ ($N_{\mu^+\mu^-}$) shows number of quark anti quark pair (muon pair) per MB Pb+Pb collision.

| | c $\bar{c}$ | b $b$ | Drell-Yan (1-100) GeV |
|---|---|---|---|
| Cross Section | 3.146 mb | 89.25 $\mu$b | 174.80 nb |
| $N_{q\bar{q}}$ | 17.8064 | 0.5051 | – |
| $N_{\mu^+\mu^-}$ | 0.5515 | 0.0053 | 0.0009893 |

## Thermal dilepton production

The contribution of thermal dileptons is calculated assuming that QGP is formed at initial temperature 636 MeV and initial time 0.1 fm and cools by Bjorken hydrodynamics. The total thermal dilepton emission rate is given by the sum of corresponding rates in the QGP and hadron regions integrated over space time volume. The dilepton emission rate in the quark sector considering the processes

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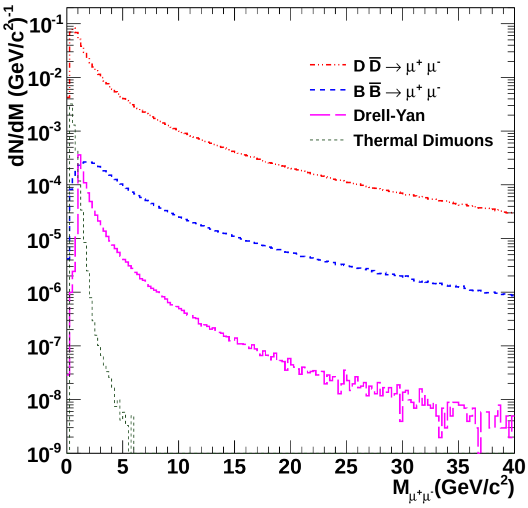


FIG. 1: Relative invariant mass distributions of decay muons from thermal, open beauty, open charm and Drell-Yan at $\sqrt{s}_{NN} = 2.76\ TeV$.

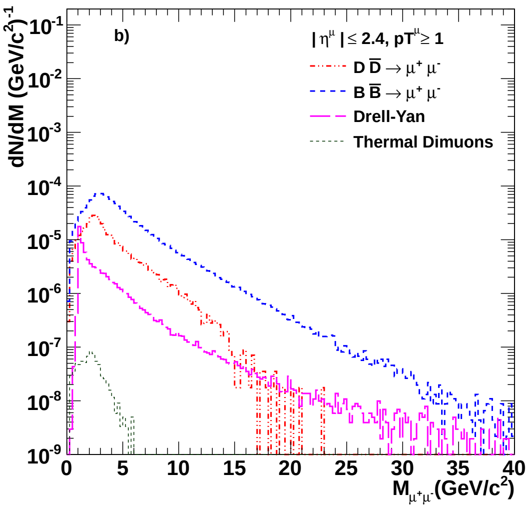


FIG. 2: Relative invariant mass distributions of decay muons from thermal, open beauty, open charm and Drell-Yan at $\sqrt{s}_{NN}$= 2.76 TeV, inside CMS detector($|\eta^\mu| \leq 2.4$).

($q\bar{q} \to l^- l^+$) is given [3] by

$$\frac{dN}{d^4xd^2p_Tdyd M^2} = \frac{\alpha^2}{8\pi^4} F \exp\left(-\frac{E}{T}\right). \quad (1)$$

Here, $\sigma(M^2) = 4\pi\alpha^2/3M^2F$ and $F = \sum e_q^2 = 5/9$ for quark phase. For hadronic phase form factors from low mass resonances are ignored as we concentrate more in the higher mass ranges. The dilepton distribution is generated by Monte Carlo using the $M$, $p_T$ and rapidity distributions of thermal dileptons.

## Results and discussions

Figure 1 shows the dimuon invariant mass distributions from open charm, open beauty and DY with thermal dimuons normalized to per minimum bias Pb+Pb event at $\sqrt{s_{NN}}$ = 2.76 TeV. It can be seen that dimuons coming from semileptonic decay of $D\bar{D}$ mesons dominate in all mass regions because at these energies, $c\bar{c}$ production cross section is very large. Except at very small mass ranges ($\sim$ 2 GeV/$c^2$ ) semileptonic decay of $B\bar{B}$ mesons is the second main contribution. The figure 2 shows dimuon distributions with a single muon $|\eta^\mu| \leq 2.4$ and $p_T \geq 1$ GeV/$c$. Since the muons coming from $D\bar{D}$ decays at low $p_T$, this contribution goes down. The contribution from thermal also goes down as they are made from low $p_T$ muons. Thus, beauty contribution becomes dominant over other sources. The present study gives insight into role of dilepton components in various kinematical regions relevant for LHC detectors. It can be concluded that although open charm production cross section is maximum at LHC but In central region like CMS (Barrel+Endcap) and ATLAS, bottom and DY contributions will dominate. In forward regions like ALICE muon arm, the charm and bottom dimuons are much larger than the other two sources.

## References

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